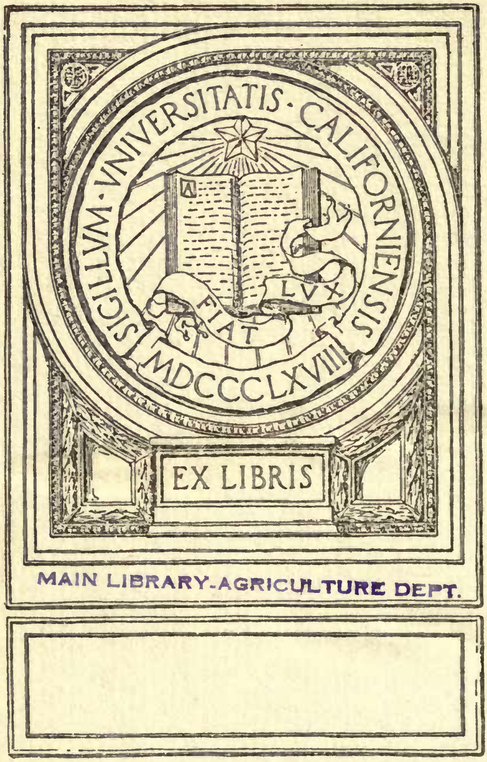
THE MANAGEMENT
OF
ENGLISH WOODLANDS

W. F. BEDDOES



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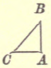
[1] In the triangle 

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THE MANAGEMENT
OF
ENGLISH WOODLANDS

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CALIFORNIA

BY

W. F. BEDDOES

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INTRODUCTION

The first question in practical forestry is, What kind of trees should be planted? This work has been written under the conviction that the English planter who plants his woods with a view to the realisation of a profit by the sale of the mature timber must rely mainly on three trees only, namely, larch, ash, and oak. Other trees may be valuable in particular situations or with reference to particular markets, but as the main sources of profit from planting they cannot equal larch, ash, and oak.

The question, What kind of trees should be planted? may be answered by saying, Only those kinds which have been proved to be attractive to English timber-merchants; other kinds are experimental. A prudent man, when he plants in the hope of realising a profit, will keep his experiments within moderate limits.

Other trees may in some circumstances be planted with advantage. Some districts are particularly suitable for other trees, which there grow to a large size and command a ready market. Where local circumstances thus point out a tree, it should be planted. Also a planter, although anxious to make a profit, will probably not be exclusively influenced by financial considerations, and will plant some trees, not very likely to sell well, in order to gratify his æsthetic taste, because they add beauty and variety to the wood. Still, these trees require a special reason to justify their place in a wood. In the point of view of planting for a profit, larch, ash, and oak stand in a class by themselves.

The climate of Great Britain is very favourable to the growth of ash, oak, and all broad-leaved trees. It is not quite as good for larch as the climate of Switzerland, but it is better than that of the greater part of France and Germany.

The soil of woodlands is almost always very poor. As a rule no land is planted in countries of settled civilisation, if it can be used for agriculture. The task of the forester is to grow woods on land which in quality is between the worst agricultural land and sterility.

The English planter suffers from many disadvantages. One of these is the great difference in price between the timber in the round which he sells and the sawn timber. Not unusually the price of sawn timber is more than three times per cubic foot the price of the tree from which it has been cut. The important fact which the timber-grower should always remember is that his margin of profit is very small. The feller, hauler, railway company, saw-mill, and timber-merchant absorb so much of the money which the ultimate customer pays, that a very small residue is left for the grower of the timber. The classification enforced by the railway companies, their charges and their preferential treatment of foreign timber, may possibly be justified by cogent reasons, but it cannot be denied that they produce a considerable diminution of the price which a timber-grower might obtain under more favourable conditions. There is hardly any grower of a natural product who has so small a proportion of the profit made by the sale of the converted article as the grower of timber in England. Better organisation among timber-growers and better arrangements for marketing their timber might prevent, or at least lessen, these disadvantages. At the present time they exist, and cannot be ignored in any consideration of the subject of commercial forestry.

The public burdens on woodlands are not the least of the disadvantages which attend timber-growing in Great Britain. Woodlands are subject to the poor rates on an assessment of their prairie value, and they do not share in the one-half exemption given by the Agricultural Rating Act to agricultural land. They are assessed for Income Tax under Schedule A at a figure which is usually the same as the Poor Law Assessment. They are also assessed for Income Tax under Schedule B at the same figure, or alternatively they are assessed under Schedule D if the timber-grower so elects. The timber, when felled or sold, is liable to death duties at the rates attributable to the value of the estate on which it grew. The result is that English woodlands are subject to heavy annual payments in each of the many years that elapse between the planting and the sale of the mature crop, and also a heavy deduction for death duties is made from the sale price.

The greater part of the imported timber sold in England in competition with British-grown timber is either Scandinavian and Baltic or Canadian. It is self-sown on land which is practically free from taxation, and, in the majority of cases it is water-borne from the forest to the English docks. France and Germany are timber-importing countries.

The English planter has the disadvantages set out in the preceeding paragraphs. Also the conditions of climate and market are different from those on the Continent or in America. English forestry cannot, therefore, from the point of view of an owner or land-agent, be adequately treated as if it were merely a branch of continental or world-wide forestry.

A thoughtful observer who considers the difficulty of forestry and the disadvantages which beset English owners will be amazed at the excellence and the quantity of the timber in English woods. In the past a depreciation of English woodland management has been fashionable, and considered to be some proof of superior wisdom and freedom from insular prejudice. At the beginning of the war there were numerous letters in the public press and speeches by those who professed to speak with expert knowledge, stating that, if the war lasted two years, all the woods in the country would be unable to produce sufficient pit-props for the mines. The great masses of plantations which now exist at the end of a four-years war show that the quantity of timber in English woods had been grossly under-estimated.

The public returns show that from 1914 to 1916 the imports of timber had fallen from eight million loads to six million loads. Possibly these figures do not include all the timber imported into England by the Government, nor all the foreign timber imported into France for the use of the army. Whatever may be the precise figures there can be no doubt that during the war the timber used for pit-props and for army purposes, both in France and England, was mainly drawn from the woodlands of the United Kingdom. There is also no doubt that the country has taken this timber at very cheap rates. No timber during this war, not even the best qualities of ash, has made better prices than were obtained during the Napoleonic wars. Nearly all woods have been sold at a figure which represents less than 4 per cent. of the capital sunk in their production. If there are any woods which sold for more than 4 per cent. of the cost of production they must be extremely exceptional cases. Most timber sold during the war was taken at prices compulsorily fixed by the Timber Controller or the War Losses Commission. No figures have been published showing on what basis they proceeded in fixing prices, but it is fairly certain that the compulsory prices for oak gave the grower not more than 1 or 1½ per cent. of the cost of production, and that the price of ash and pit-props never exceeded 4 per cent.

Forestry, like all other arts for growing natural products, has three main divisions: the selection and preparation of the soil, the cultivation and harvest of the crop, and the sale of the crop, which is the last in date, but is the aim which the grower has in view from the beginning. A farmer can generally anticipate, within reasonable limits, the price which his crop will bring, and can regulate his cultivation accordingly. If he is mistaken he loses the labour and expense of only one year. A tree-grower can form no notion of the price of his crop fifty or a hundred years later than the planting. His only plan is to make the assumption that during the growth of the wood the price of timber will not fall. If his market, owing to altered circumstances, fails, and his calculation of the price proves to be mistaken, he loses the labour and expense of many years. As for example, when a change in trade has depreciated the value of the crop of a coppice wood that had been very remunerative, it may be impossible either to find a purchaser for the crop or to alter the method of management without incurring excessive cost.

The long period between the planting of young trees and the harvest of the mature timber has serious effects. By reducing the chance that the planter will reap a personal benefit from his expense and labour, it causes a reluctance to plant. The long period of growth also prevents the same man who plants the crop from personal observation of it from the start to the finish. Many years may pass before the consequences of a mistaken method become evident. Mistakes can rarely be remedied. Experiments are very difficult to contrive.

A farmer knows from books and teaching the usual practice of growing a crop, but for the details of cultivation he mainly relies on his own observation or the consensus of the views held by the most intelligent farmers in his neighbourhood. As the result of successive trials for innumerable years it becomes known what fields are suited for any crop, what variety of seed and what quantity should be sown, and all the other details of cultivation have been repeatedly tested.

In forestry it is different. In many cases there is no past history of the land which can give assistance to the forester. There is no knowledge of the capacity of the site for growing timber, gained by the experience of many crops of timber on that land. A landowner may know that a plot of land is apparently such as is usually suitable for certain trees, and that these trees are usually planted of a certain size and distance apart, but he has no past experiments to guide him in deciding how far the general rules should be varied to meet the local peculiarities of his own land, and whether the land is really as suitable for timber as it seems to be.

Forestry is an art, the rules of which cannot be stated with precision. Rules may be of great value. A forester who has an adequate knowledge of the methods by which success has been obtained by others is more likely to be successful than another man of equal ability who has no other guide than his own experience. But no rules can apply accurately to the local peculiarities of different properties. Success in forestry mainly depends on personal observation and practical sagacity. It is a great mistake to demand in any art more accuracy than the subject admits, or to assume, without proof, that forestry is capable of precise rules, like the arts of building or painting. If rules of forestry could be discovered which were universal, precise, and useful, the knowledge of them would not make a man a forester. They would be like a good library, which is useful but does not make a man a good scholar.

The modern method of education increases the tendency to over-estimate the theoretical side of forestry and to ignore the practical difficulties. A man who has been taught forestry in a college by means of lectures and examinations, joined to occasional excursions in woods, has no experience in overcoming the difficulties of daily work in the woods, and therefore they do not appear to him to be of great importance. He cannot judge how far he is able to meet them, or to what extent they interfere with the possibility of carrying out what he may rightly consider to be the best method of management. The practical difficulties of forestry will be apparent to any one as soon as he undertakes the management of woodlands. The total of all his expenses must be kept below the total of all his receipts, and timber in comparison with other crops brings very small receipts; therefore, the forester is always hampered by the necessity of exercising a rigid economy. The site of his woods may be the poorest soil in the country, given to forestry only because it is fit for nothing else. Frequently the woods will be in remote districts and with bad roads, so that haulage, the supply of labour, and supervision will be difficult and expensive. In winter prolonged periods of bad weather may stop all work. In summer there may be droughts, killing young trees and exposing the woods to the risk of fire. Gales of wind will injure the plantations. Rabbits and trespassing sheep and cattle may, in spite of the utmost care and vigilance, do serious damage. Sometimes, for no apparent reason, the growth of woods will disappoint the forester. When the woods are ripe for sale the forester must deal with timber-merchants, a class of men whose training, on whatever lines it may have been conducted, has made them most efficient in the protection of their own interests.

Ignorance of practical difficulties produces extravagant promises of success. If it is objected to the enthusiast that his promises cannot be fulfilled, unless his woods grow much larger quantities of timber than have hitherto been seen in English woods, he confidently replies that there will be a great difference in the quantity and quality of the timber, because earlier woods were the result of rule-of-thumb practice, while his woods, as the result of sound principles and scientific knowledge in forestry, will be fully stocked with excellent timber. The sanguine prophet of great improvements in forestry due to scientific knowledge has at least one undoubted source of comfort, his views cannot receive an early refutation. Before the woods grow to maturity and the results are known, both he and his critics will for the most part have left this world.

The mere failure of a wood to thrive or to produce an adequate income does not necessarily involve blame to the planter or to the present owner, if they are different persons. Success cannot be always attained in attempts to grow timber crops upon land on the margin of sterility. In the cultivation of such land some failures are inevitable: the result may show that enclosure and planting have done no more than substitute dead and stunted trees in the place of worthless herbage. Nor is the existence of a crop of trees inferior to what could grow on the same land necessarily a proof of bad management. The cost of cutting down the unprofitable trees and replanting the land may be so great compared with any probable receipts that it would be wise to allow the wood to remain in the present state.

In all countries the management of woodlands artificially created must be a difficult art, because it means growing good crops on poor land. The long period of the growth of the trees deprives the forester of the advantage of the personal observation and experiment which help the farmer. In Great Britain the burdens of taxation and foreign competition are especially severe. The result is that the account of expenses and receipts of forestry in England cannot be made to square unless the planter shows great care in the planting and the maintenance of his woodlands, methodical management, adroitness in selling the timber, and always avoids spending money on expensive methods when adequate methods can be followed at moderate cost.

PLANTING

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CHAPTER I

PLANTING

Economy in planting is essential if plantations are expected to produce a profit. In the long interval between the planting of the young trees and the sale of the mature trees the planter loses his money and the interest which that money would have produced; therefore, in the accounts which show the financial results of the plantation, compound interest must be charged. In accounts taken at compound interest over long periods items at the commencement of the account accumulate to a very large extent. It is clear that unless the total amount on the debit side of the account is to exceed any sum which is likely to be produced by the sale of the mature trees, the initial cost, that is, the cost of planting, must be kept to the lowest possible figure.

It may be objected to the plea for great economy in planting that the long interval between the planting and the final sale makes it certain in most cases that the same man who plants will never sell the mature trees, and that therefore planting cannot be looked at merely as a commercial undertaking, and also that a man who plants from a sense of duty or the love of seeing on his land thriving plantations will not pay much attention to the expenditure in planting of a few pounds more or less per acre. There may be something in the argument that planting cannot be considered as simply a commercial undertaking, but even proof that there is no pecuniary profit in planting can be no excuse for unnecessary expenditure.

Altitude has little or no effect on the climate in the British Isles. There are no lofty ranges of hills, where the traveller, as he ascends, passes through different zones of climate. Altitude in this country is important to the planter, as it increases the exposure to gales and to denudation. There are very few flourishing woods above the 1,000-foot contour-line. Planting at a greater altitude is, as a general rule, a very doubtful experiment, but this rule can be modified by local circumstances. The situation of plantations on high ground is relative. Trees thrive better at 1,100 or 1,200 feet if protected by still higher hills, than many planted at 800 or 900 feet not so protected. A low altitude is not, in itself, an advantage. Lands exposed to gales from the sea and large level plains are unfavourable for planting, however moderate their altitude may be.

The geological character of a district, unless it is a limestone or chalk formation, does not very seriously affect the size or the kind of the trees which can grow on it. As a general rule, if a planter is satisfied with the visible soil, he need not inquire into the nature of the underlying rock on which it rests.

The aspect of a wood does not have a very important influence on the growth of the trees. A north aspect is free from sudden variations of temperature, and in spring the new buds are retarded, so that there is a diminished chance that they will be injured by late frosts. Trees on a south aspect are liable to be brought into bud by the heat of the sun, and so become more susceptible to injury by frost at night. A high dry bank facing south is the worst aspect, but the injurious effects of this aspect are mainly confined to the early years of the plantation. All trees, but particularly beech and larch, when planted on a dry south bank, may die in large numbers if the next summer after planting is hot and dry. If that summer is rainy, the probability is that the young trees will establish themselves and afterwards grow well. Some excellent woods grow on south banks.

A bank with a northerly aspect is more likely to be suitable for a plantation than a bank with any other aspect. Such a bank is free from the danger of being burnt by the sun, and is not generally exposed to violent winds, and the buds of young trees are not brought out prematurely.

Banks with an easterly or westerly aspect are greatly improved for planting by the presence of some old trees on the side facing the prevailing wind.

Situation and soil are important matters for the consideration of a planter. One of the practical difficulties of planting is that, as a rule, a planter has not much choice in the selection of the site of his proposed plantation. He cannot expect to grow any trees equal to the famous trees of past generations. They grew in good land and were probably self-sown, and by a lucky chance escaped from being browsed by cattle in infancy. In these days good lands are used for farming, and plantations are confined to the inferior soils. On such soils there is not nutriment enough to grow great masses of wood.

The improvement of damp situations by drainage is possible. A few drains to take the water from hollows or swampy places are useful and not expensive. A regular drainage system is expensive, and should not be attempted unless expense need not be considered. If there is so much stagnant water that drainage is necessary, it is a prudent course to leave the land unplanted.

Instead of adapting damp ground to the growth of trees which cannot thrive in it as long as it is damp, the best plan is to plant trees which naturally thrive in damp ground, such as ash, Sitka spruce, alder, and black Italian poplar.

In addition to the expense of extensive drainage, there is the further objection that it may involve over-drainage. The drains may remove a dampness which is essential to fertility. It is not uncommon to find woods intersected with deep ditches and composed of stunted and stag-headed trees, suffering from drought. The roots of the trees to some extent themselves act as drains. They suck up the water, and thus diminish the dampness in the ground. Shallow pools frequently dry up when woods grow round them. Still, this suction of water by the roots of trees is very limited in extent. Trees are frequently planted along mill-courses and small streams, and do not seem to diminish the flow of the water.

Trenching the ground is, like a regular system of drainage, very expensive. It may in some cases enable trees to grow where otherwise they could not live, or it may give trees a much quicker start than they would have without it, but as a general rule better results are obtained by a choice of trees suitable for the existing conditions of the soil than by any attempt to alter the soil conditions. The benefit given by trenching seems to be confined to the early years of the trees. After fifteen to twenty years from the planting it is rarely possible to see any difference between those planted on trenched ground and those on untrenched ground. The cost of trenching makes it extremely uncommon in any woodlands managed on a commercial basis and with a view to the realisation of profits.

Ploughing the land in strips as a preparation for planting is on flat land sometimes both useful and economical. It loosens the soil more effectually than mere digging the holes, and also reduces the probability that the young trees will be over-topped by heather, fern, or gorse.

The formation of fences is an expensive item. The cost of erecting a fence round a small plantation, say, one of four acres or less, may vary very much according to the cost of labour and material in the locality of the plantation, but in every case the fence would almost certainly cost more than the trees. The larger the plantation the less is the cost per acre. The ratio of increase between acreage and fences, assuming that the plantation is in the form approximately of a square, is that a fourfold increase of acreage requires a twofold increase of fences. Suppose that a plantation of four acres cost £12 for fences—that is, £3 per acre—then sixteen acres require £24, or £1 10*s*. per acre, and sixty-four acres require £48, or 15*s*. per acre. A forty-acre plantation costs for the erection and maintenance of the fences only double a ten-acre plantation.

Long rectangular plantations have the largest amount of fences per acre. Circular fences should be avoided, because they are difficult to erect.

In order to make use of existing fences, and so reduce the cost, a plantation should, if possible, be made on the site of an old wood or on land adjoining an old wood; and in the case of a plantation made on land separate from other woods, entire fields should be planted, so that use can be made of the existing fences, and if this is impossible, the plantation should be of as large an extent as circumstances permit.

Wherever the woods are of a straggling and irregular form it is generally possible, by planting land between the woods, to make a great reduction in the amount of fencing compared with the acreage of the woods.

The usual form of a new plantation-fence is double: there is a fence of wire-strands or rails, and on the inside of that fence a hedge is planted. The thorn hedge is intended to be the permanent protection of the plantation, and the wire or wood fence to be the temporary protection of the thorn hedge. In most cases the thorn hedge should be omitted; it causes considerable expense in planting and subsequent maintenance. If the trees are planted close to the hedge it rarely grows satisfactorily, and if a space of 8 or 10 feet on the inside of the hedge is left unplanted, there is a serious loss of ground. The hedge is generally unnecessary. A well-made fence will last at least twelve years, and when decay begins the plantation should supply from thinnings materials for repairs.

Local habit generally shows what is the most convenient fence, but in the absence of some good reason to the contrary a wire fence should be adopted. The posts should be 8 feet apart, 2 feet 6 inches in the ground, and 5 feet above the ground, of oak or larch preferably, and felled near the proposed fence so that the cost of haulage may be moderate. They should, if possible, be barked a few months before erection and allowed to season. Soft and perishable wood can be used for fencing if creosoted. Creosoted posts, concrete posts, or iron standards can be used whenever there are no natural posts available. The preference of either of these depends on the price for which they can be brought to the fence. The direction of a new fence should be so laid out that it does not, unless absolutely necessary, cross ground to which the fencing materials can be carried only by hand.

A wooden rail at about 14 inches from the ground binds the posts together and strengthens the fence; it also hinders sheep from pushing through the wires. A barbed wire, with barbs 6 inches apart, is most useful when fixed as the top wire at about 5 feet from the ground. In that position it hinders transit by trespassers and pushing by cattle and horses. Two plain wires between the barbed wire and the rail and one under the rail make a useful fence, and cost as much as can prudently be allotted to making a fence.

Galvanised wire has in recent years almost superseded ungalvanised. It is almost certainly much more immune from destruction by rust, but there has not been sufficient time to definitely decide how it compares with ungalvanised in strength and duration.

Wire netting, 4 feet high on stout supports 8 feet apart, is very convenient as a temporary fence on ground with a level surface. There should be a barbed wire at the top and another 4 inches from the bottom of the netting. The netting is more expensive than wires, but costs much less in the labour of erection, and can be removed and used elsewhere.

The objection to small woods is confined to those which require new fencing, and is based only on expense. As regards the growth of the trees small woods have advantages over larger woods. If instead of clear-cutting and replanting a block of sixteen acres in a large wood two separate blocks of eight acres each had been clear-cut and replanted, the probabilities of success would have been increased. The larger the size of the plantations the more easily disease spreads, and the free circulation of the air in the centre of large plantations is difficult.

Plantations in the middle of larger woods should not be of a very small size, such as an acre or less. The tall trees of the rest of the wood surround small plots of ground like walls, excluding unduly light and air. Also the fog and mist collect in small plots.

Fencing with rabbit-proof netting is a great addition to the cost of a plantation and is very frequently useless. Unless the netting is regularly inspected the rabbits will make burrows under it. In winter the snow drifts against the netting and the rabbits walk over it. Constant warfare against the rabbits is a much better protection to the young trees than netting. Snares will thin the numbers of the rabbits, but will not exterminate them. Ferrets must be also employed. A landowner, before he plants land near the estate of a neighbour who does not keep down the rabbits, should consider very carefully if there is much probability that a plantation in that position will be renumerative.

If a plantation is made in a situation where it is impossible to keep down the rabbits, rabbit-proof netting is absolutely necessary. A clear space of two yards wide should be kept outside the netting to enable woodmen to see if the rabbits are working under it. The erection of rabbit-proof netting should be confined to the properties of planters who are comparatively indifferent to expense.

The distance apart from each other at which trees should be planted is a matter of the greatest importance. For many years most books on forestry published in England recommended close-planting—namely, that the trees should be planted at 4 or 3 feet or even less apart—and they supported this opinion by the example of the Continental Forest Departments. More recently this opinion in favour of close-planting seems to have been somewhat modified. The losses in the German State Forests from windfalls, disease, and injurious insects have been so appalling as to be almost incredible. These losses may have been the joint result of many faults in management, but it is highly probable that the most serious cause was the unhealthy condition of the young trees due to too close-planting.

The disadvantages of close-planting are twofold; first the expense, and secondly the effect on the trees and on the soil.

Trees which are planted together closely, almost immediately commence a struggle for existence; in this struggle a large number of the trees die. Both theory and experience seem to justify the view that those young trees which emerge successfully from the early struggle for existence may have their vitality permanently impaired by it, if it begins while the trees are very young, and therefore weakly. Further, a struggle for existence of nearly 5,000 young trees on an acre of poor ground is a serious strain on the fertility of the soil. Close-planting increases the warmth in the plantation and impedes the free circulation of air. Warmth and exclusion of air are highly predisposing causes of disease to all trees, but particularly to very young trees whose vitality has been impaired by a premature struggle for existence.

The advocates for close-planting urge that a struggle for existence among the trees is necessary to stimulate upward growth and to keep the stems free from lower boughs, which produce knots and so reduce the value of the timber. Granting that this is quite accurate, it does not follow that a struggle for existence, if it commences very early in the life of the plantation, may not do more harm than good.

The practical result seems to follow; namely, that the best distance at which trees should be planted is that which their boughs can cover in four or five years without crowding each other. By planting at this distance the strain on the fertility of the soil and on the vitality of the young trees does not commence until the trees are thoroughly established. Also at that age the absence of density does very little harm. Any small side boughs which then grow die off later and leave no knots in the boles of the mature trees.

The actual distance apart of the trees must be determined by the situation, fertility of the soil, and the nature of the trees. Some plantations, both of pure larch and of larch and oak mixed, planted 5½ feet apart, have grown very well. It is hard to conjecture any reason why in ordinary cases trees should be planted closer than 5 feet apart.

It is unnecessary to state any dogmatic rule about the number of feet which is the proper planting distance, for it is one of the few subjects connected with tree-planting which every one can test for himself by experiment. It is certainly possible that in some cases a plantation made with trees originally planted 5½ feet apart, will at twelve years old be more healthy, with a complete canopy over the ground, more vigorous, and more able to resist the wind than a plantation in which the trees had been planted at a less distance.

There are two cases in which close-planting may be useful. First, exposed moorlands, for they are so cold naturally that the young trees cannot establish themselves without an increase of warmth, and a heavy mortality must be expected, so that unless many more trees are planted than are likely to live, there will not be a complete crop; and secondly, situations where there is a good market for hop poles and the soil is fairly good. In these situations the advantage of having early returns makes it prudent from a financial point of view to incur some risk of injury to the trees and to the soil.

It may be urged that according to the arguments already given against close-planting, it would be better to plant at much wider distances than 5½ feet, say at 8 or 9 feet. The advantages, it is claimed, would be economy in planting, for at 8½ feet apart, only 600 trees per acre are required; and as each tree would have ample growing space, it might be reasonably hoped that there would be increased health and power of resistance to wind. The answer is that very wide-planting has dangers as great as very close-planting. Trees planted as far apart as 8 or 9 feet would probably develop strong side-boughs before they closed together and the struggle for existence began, and whenever a tree died or was removed because it was crooked, there would be a serious gap. In such a plantation the density of crop necessary to secure vigorous upward growth and freedom from knots would probably be postponed until it was too late.

The best time for planting on ordinary soil is the end of November, after the fall of the leaf and before the ground has been chilled by the winter. On very wet soils planting is best done in late spring. Where the planting is extensive the work is necessarily, almost always, carried on continuously throughout the winter months, whenever the weather is open. During frost or heavy rain the planting must be stopped. It is absolutely necessary to protect from frost or drying winds the plants in the interval between the time when they are lifted in the nursery and when they are planted in the wood. On the journey they should be covered with leaves or sacks. On the arrival at the wood the bundles should be opened, the plants should be placed by their heels in a trench and the roots completely covered with leaves and soil. No more trees should ever be taken out of the trench than can be immediately planted. However open the weather may appear, these precautions should not be omitted. They are very inexpensive, so little is lost, even when they are shown to have been unnecessary. Nothing can be more useless than planting trees whose roots have been frosted or dried. In dry ground the soil is mellowed by the sun and rain if the turf is removed and the holes are made some weeks before planting. On damp ground the holes should be made at the time of planting, otherwise the rain collects in them.

The ground-plan of the plantation should be such that even on large areas of rough ground the workmen have as little difficulty as possible in finding the right place in which to make the holes when planting, and afterwards in cleaning the trees. The distance between the rows and the distance between the trees in the rows should be the same. A convenient and usual plan is a modification of square-planting. According to this plan each alternate row commences at a distance from the base-line equal to half the planting distance. The trees are diagonal to those on each side, instead of being parallel as they would be in square-planting. The quincunx is a ground-plan, according to which anciently the olive trees in Southern Europe were planted. It is claimed to be the best for the health of the trees and the attractive appearance of the plantation. In Johnson's Dictionary it is described as "A plantation of trees, disposed originally in a square consisting of five trees, one at each corner and a fifth in the middle, which disposition, repeated again and again, forms a regular grove, wood, or wilderness; and when viewed by an angle of the square or parallelogram, presents equal or parallel alleys." It is unsuitable for forestry generally, but it is a convenient way of laying out a grove on level ground where it is intended that there should be no thinning and the amount of expense and time that can be spent on planting is not strictly limited.

Planting is done in two ways, by notching and by holeing. In notching, the turf is cut by a spade and then another cut is made at right angles to the first cut, the turf is raised by the spade and the tree inserted at the junction of the two cuts, and the turf pressed down. This method of planting is economical and gives good results where it is practicable. In England it is often impossible. The spade cannot be used where the ground is stony or full of roots. And even where there is turf on the ground it is sometimes so thick that the soil under it is always perfectly dry.

In holeing, the soil is first loosened with a pick and then stirred with a spade. In the hole so made, the tree is planted and the soil trodden firmly round the stem. If there is any turf it is cut into two pieces and placed grass downwards on each side of the tree.

The usual height of the plant is about 9 to 18 inches in notching, and 18 to 30 inches in holeing. In some cases 3-foot plants are used. Plants which exceed 3 feet in height show a noticeable increase in cost, weight, and liability to be shaken by the wind.

It is very important that in the spring following the planting each plant should be visited and the soil near the stem firmly pressed down by the feet. It is inevitable that some plants will have been raised by frost and others loosened by wind, and unless they are straightened and made firm they will certainly wither in the summer.

There is a difference of practice about clearing young plantations from strong weeds, such as brambles, gorse, etc. Some planters think that these weeds do not cause any serious damage, and that the best plan is to leave the plantation until the trees are 12 or 15 feet high, by which time it is expected that the trees have grown above and killed the undergrowth. It must be allowed that it is useless to keep trees in a plantation as clean as those in an orchard, and that sometimes much money has been unnecessarily spent in making plantations look tidy; still, it will generally be found that early neglect of a plantation is false economy. A plantation from which the undergrowth is not cut, soon becomes an impenetrable jungle, and the planter cannot go through it and see the growth of the trees, and may be quite unaware of numerous failures in the centre.

Brambles are the most noxious of all weeds. They pull down the young trees, and by their thorns chafe the stems and make wounds by which injurious spores may enter. They should be cut in June, when they are full of sap. Sometimes they renew themselves for five or six years and are a cause of serious expenditure. Gorse, heather, and fern protect the plants from frost and the sun, and unless they press or overtop the plants, do good. They should be trimmed or cut out according to the strength of their growth. Oak stools and elder bushes generally have such a vigorous growth that they must be trimmed severely in order to prevent them overtopping the plants. Fairly long grass is also a protection against frost and sun, and need not be cut unless it is coarse and matted so that it might in winter fall against the plants and weigh them down.

On damp ground the removal of long grass and bushes is beneficial. The soil is exposed to the action of the sun and made drier and sweeter, and the plants are checked from growing long and sappy shoots, which with difficulty stand either frost or wind. On dry ground and steep banks the soil is liable to be scorched by the sun; in such places long grass and bushes may be a desirable cover.

A nursery for the growth of seedlings is a great advantage to a planter. The economy effected by the purchase of seedlings instead of transplants is so great that it more than compensates for the cost of cleaning the seedlings and the losses, and the danger of transplants being heated or frosted in railway waggons is removed. The difference in vitality of trees grown on the estate and those from a nurseryman is generally very considerable.

If the site chosen is not previously in cultivation it should be broken up, and after a fair, but not heavy, manuring, a crop of potatoes or roots taken, and after the crop has been lifted lime spread. The seedlings should be planted in spring in rows 15 inches apart and 5 inches apart in the rows. Some planters prefer two-year seedlings for the nursery to one-year seedlings. They consider that the losses in the latter are generally so great as to compensate for the extra cost of the former.

There are two kinds of nurseries: temporary, which are usually either on or near the land intended to be planted, and permanent ones. Occasionally permanent nurseries are seen with ornamental gates, and broad gravelled paths flanked by beds full of rare shrubs and trees. The owner whose finances enable him to gratify in this way his æsthetic tastes is much to be congratulated, but it may be observed that a nursery of this description is a strong indication that his woods are not managed solely on a commercial basis and with a view to the realisation of a profit.

THINNING

CHAPTER II

THINNING

THE financial results of woods planted for the growth of mature trees are largely influenced by the manner in which the trees have been thinned. Thinning is the artificial reduction of the density of a crop.

The objects sought to be attained by careful management of woods are three: first, the health of the trees; secondly, strength to withstand gales; and thirdly, the production of the largest possible number of trees of a shape and size which will attract a timber merchant. These objects are to some extent antagonistic to each other. In a very open wood the trees are healthy and sturdy, but the number of trees in the wood is reduced, they are short in height, and there are numerous knots in the timber from the side boughs.

It is in the power of a planter by removing some trees in a wood to increase the distance at which the remaining trees stand apart from each other, or in other words, to reduce the density of the crop. The necessity of some reduction in the density is made apparent by a consideration of what would happen if no reduction in density was artificially made. In the absence of any reduction in density, all the trees would rise for some years in an even height, like a crop of corn. In a poor soil there would be no further growth, the ground would be matted with roots and exhausted. The few leaves on the tops of the trees would be insufficient for respiration, and the result would be the eventual disappearance of the whole crop. Even in a more fertile situation the result would be the same for the majority of the trees—namely, eventual disappearance—but the history of the more vigorous trees would be that they would rise above the level of the crop and thus obtain sufficient light and air to support life, and by the shade of their boughs they would hasten the death of the remainder. At later stages of growth, as the existing trees increased in size they would crowd each other, and further struggles for existence would arise, until at last, by the disappearance of all the others, a few remaining trees would have sufficient light and air and also sufficient space in the soil for the development of their roots.

From this consideration of the issue of a struggle for existence, uninterfered with by artificial thinning, it would appear that the advantage of density of a crop is that it encourages upward growth and freedom from knots, and that it has the disadvantage that it is a strain on the fertility of the ground and on the vitality of the trees.

Throughout the life of the plantation, density should not be maintained beyond what is absolutely necessary to maintain upward growth and freedom from knots. If this limitation of density is exceeded there is, in addition to the risk to the fertility of the soil and the vitality of the trees, also a risk of completely stopping diameter growth. A check on diameter growth is inevitable in the period of vigorous upward growth, but the diameter growth must not be killed.

Experience shows that if growth, either in height or diameter, is once seriously stopped by unfavourable conditions, it cannot be restarted when the conditions are made favourable. The density of a wood which is ultimately to be sold at a good price to a timber merchant should be such as to hasten vigorous upward growth and yet keep alive growth in diameter. If the trees grow up as a crop of lofty poles, they will probably be blown down by a gale; and even if they escape that fate, they will never, to whatever extent they may be thinned, attain a size and shape that will attract an English timber merchant.

Professor Schwappach, in an address read before the Royal Scottish Arboricultural Society on August 3rd, 1896, said: " A timber merchant looks for trees as long, straight, and cylindrical as possible, with the minimum number of knots." This statement may be quite accurate in Germany, but it is not an adequate account of an English timber merchant's requirements. His ideal is a tree from which he can cut the largest number of sound planks with a minimum waste. Length is highly desirable, but freedom from knots and a good diameter are essential if the wood is to bring a good price.

A proper density of the crop is the only practical method of making the trees so grow that the plantation may realise the best financial result. Too little density encourages side boughs and knots and a shortened stem. An excessive degree of density produces an unhealthy and valueless crop.

In a pure larch plantation the risk of destruction by the larch disease is a very real one. The health of the trees should be the first object of the owner. A free circulation of the air is the best way of checking disease. If, therefore, at any time serious signs of disease are present, the plantation should be thinned until the air circulates freely. It is possible that a thinning heavy enough to produce this result may so reduce the density that it will not be sufficient to induce upward growth or to prevent the growth of unsightly side boughs. These disadvantages must be accepted by the owner. Stunted and knotty trees are preferable to trees destroyed by disease, and if the disease should be early checked there is some hope that the trees may resume vigorous and satisfactory growth.

As a rule, in pure larch plantations the natural density does not require artificial interference until the trees reach a height of about 15 feet. At this period there should be a thinning to remove all trees that are dead or so completely suppressed that they are certain to have no more useful growth, and trees that are seriously diseased. A slightly diseased tree need not necessarily be removed, for such frequently recover.

In districts where there is a remunerative sale of young trees, as for hop poles, the subsequent thinnings should be repeated every three years, until the trees are too big for sale as poles.

In these thinnings the worst trees should always be selected for removal, and the density may be reduced until the trees stand so far apart that the extremities of the boughs only touch each other. The advantage of these removals of a fairly large number of trees is that if some return, at an early period in the growth of a plantation, is obtained, it makes a great difference in the financial result. The risk of checking upward growth is not very serious, because at this early period the young trees have such vigour that probably the required density would be soon renewed.

It is an excellent rule to thin larch plantations moderately and often; therefore, where time and expense are of minor importance, subsequent thinnings from the first until a height of about 25 to 30 feet has been reached may take place every three years, even in the absence of a remunerative sale of the removed trees.

In ordinary cases, where time and expense are of considerable importance, a thinning about every ten years will be sufficient during the period while height-growth is vigorous. A stuffy feeling of the air in a plantation, lanky stems, a bark which instead of a dark brown, with streaks of rich brown, is pale and close, and roots appearing out of the ground are signs that the time for a thinning has come. In their absence there is no necessity to thin merely because the boughs of the trees interlace. Even when a thinning is desirable, it may, if financial reasons make that convenient, be postponed for one or two years without serious risk, by knocking off the dead lower branches of the larch so that there may be an additional access of air to the interior of the plantation.

No definite rules can be laid down about the distances at which the trees should stand apart after a thinning. The circumstances of each plantation are different. In the same plantation there may be groups of poor trees close to each other, and also groups of good trees. No prudent owner would remove both good and bad trees in the same proportions; he would preserve as many as possible of the good trees and remove as many as possible of the bad.

The general principle in thinning a plantation is to remove from it exactly so many trees and in such situations that those which are left should have as far as possible the exact amount of proper density, namely, the density should be so close as to encourage upward growth, and yet not so close as to stop diameter growth. The roots must have room enough to spread so that they can withstand the wind. The crowns must have light enough to be vigorous. All trees injurious to others of more value than themselves should be removed. Suppressed trees need not be removed if they do no harm, and in some cases they may be useful by preventing the undue side growth of a vigorous tree, or by helping to keep the wind out of the plantation. The density should be reduced to the point that the upward growth is not so much exaggerated that the trees become weak and lanky. Healthy and vigorous crowns will endure without injury a considerable crowding of their boughs.

Two courses of management are available when the trees are approaching the end of the upward growth. If the trees show that they are not vigorous, and the poverty of the soil or the exposure of the situation indicate that really fine timber cannot be reasonably expected, the best financial result may be obtained by the omission of any further thinning and a sale of the timber when height-growth finally ceases.

Plantations above the 800-foot contour line should, as a rule, be treated in this way, unless there are special advantages of soil or situation.

In larch plantations which at fifty to sixty years of age still show a vigorous growth, the density of the crop should be removed as soon as the height-growth is seen to be approaching the end. At that period the density has done its work and is of no more use. An effort should be made to produce that growth in diameter which makes the trees of considerable value.

By the removal of all the inferior trees the plantation should be thinned until each of the remaining trees stands clear of its neighbours. For fear of damage by windfall this partial clearance may be effected by two thinnings. The removal of the density of the crop should not be delayed until height-growth has ceased, for at that time there is a reduction of vigour in the trees and they cannot then produce as large a diameter growth as they would have done if full light and air had been admitted into the plantation a few years previously.

During this last stage in the growth of a larch plantation the soil will, in most cases, become covered with a growth of broad-leaved plants. Under favourable circumstances the largest and most valuable larch timber may be produced by trees which, near the end of their height-growth, have been thinned until each tree has full light and air for the crown and ample room for the roots.

In pure oak woods in England, grown in suitable situations, there is no real risk of disease, and only a slight risk of damage by windfall. There is no necessity to remove trees which are overshadowed by others; they are useful sometimes as underwood. Until the trees are about 40 feet high, no more thinning is required than the removal at intervals of about ten years of trees which are crooked and forked. After the principal part of the height-growth has been reached a sufficient number of the inferior trees should be removed to allow the crowns of the better trees, and especially of any scattered ash, fair growing space. In about twenty-five years after a thinning the crowns will again close up, and another removal of the inferior trees should be made. As the wood becomes lighter by these successive thinnings an undergrowth of hazel and small bushes will cover the ground, and the wood will present the appearance of coppice with standards. If the object of the owner is to obtain timber of the largest size and greatest individual value, the trees must be allowed to grow to full maturity, in a rotation of 180 or 200 years, and the number of first-class trees will at the final cutting be between ten and twenty per acre. It is probable that in most cases an earlier sale would be more remunerative, because the annual increment of an old oak wood may be only small.

Mixed oak and larch plantations are thinned on the principle that a good oak, when it is overshadowed by a larch, must be protected by the removal of the larch. If the threatened oak is unlikely to grow into a good tree, a larch may be allowed to replace it. The difficulty in the management of such a plantation is that the protection of the oak requires the removal of some larch at short intervals of two or three years. Small thinnings are unremunerative, and therefore liable to be neglected, with the result that the quick-growing larch overpowers the slow-growing oak. There will possibly be some parts of the wood in which the oaks are not sufficient in number to form a full crop; these parts should each be treated as a larch wood.

MIXED AND PURE WOODS

CHAPTER III

MIXED AND PURE WOODS

In the last century pure woods were rarely planted, except in the neighbourhood of mines, where some very remunerative pure larch woods were grown. As a rule most woods were planted with a mixture of larch and oak with a few other hardwoods. It was assumed that the oak had the advantage of being more valuable, and larch the advantage of quicker growth and earlier returns, and it was hoped that mixed woods of oak and larch would combine the advantages of early returns and great future value. The theory was the larch would stimulate the upward growth of the oak, and by their thinnings and final removal provide an early income, and that when the larch were removed there would be left on the ground a crop of valuable oak.

In some woods the theory was successful: the planter obtained an early income and left for the benefit of his posterity a valuable crop of growing oak. In many other woods, originally planted as woods of oak and larch, the oak have been smothered by the larch, or at least so many of them have disappeared that when the larch was removed only half a crop of oak was left on the ground. The attempt to grow in the same wood slow-growing oak surrounded by much more numerous quick-growing larch demanded constant care in the management of the woods, and this care was not always exercised.

The present position is this : Financial reasons generally make a planter reluctant to plant a pure oak wood, from which there can be no substantial return for a hundred years. Without the use of larch or some other quick-growing tree it is hard to see how any oak can be planted under present circumstances, and the example of many of the mixed woods planted in the last century show that oak planted among larch are, in the absence of great care in the management, likely to be smothered by the larch.

The result of these difficulties is that the planting of pure oak has become uncommon, and mixed woods of oak and larch are diminishing in number. This reduction in the amount of oak planting is a matter for regret. The oak is a noble tree, the pride and characteristic of

English scenery. A fine oak tree or a fine oak wood is a source of legitimate pride to the owner. Even from a financial point of view there is much to be said for the planting of oak. No doubt the present price of oak timber, unless it is of the first quality, is very poor, but all planting is to some extent a speculation, for no one can foresee with certainty the price which timber trees will produce in the future. The varied qualities of oak—strength, elasticity, durability, and ease in working—make it one of the most useful trees in the world, and there is a reasonable ground for an expectation that it may in the future greatly appreciate in value.

Few, except rich men, can plant on any large scale pure oak woods, but there are in most properties opportunities of planting oak and ash on small pieces of land which are better adapted for them than for larch.

Occasionally very small woods are made on good land for the sake of game or for the improvement of the landscape. These might with advantage be made of oak and ash. The profit from such small woods, if there is any, is a matter for the distant future, and the substitution of oak or ash for larch will not injure the planter.

A planter, if the circumstances of a plantation give him no chance of pecuniary profit, may as well plant trees which will grow vigorously for a hundred and eighty years as trees which grow for sixty or seventy years.

In spite of the many failures of mixed woods in the last century, they are a very advantageous method of planting, if care in management is exercised—and there is no reason why there should not be careful management. Five or 5½ feet apart is close enough for the young trees to be planted. A method once generally practised was to plant first the oak at the distances at which it was intended that they should ultimately stand, and to fill up with larch to the distance of 3 or 4 feet apart. The result is, that if any of the oak die, the remaining oak trees on each side of the dead one stand apart at excessive distances. A better method is to increase the number of oak, so as to have a sufficient number in reserve to take the place of those which die, are unpromising, or are smothered.

In this method the oak are planted in the rows with the larch; for example, every alternate row is pure larch, and in the intermediate row there is an oak and then a larch, or an oak and then two larch, according to the quality of the soil. This method cannot be carried out strictly, for it sometimes happens that the place assigned to an oak is stony, or for some other reason obviously unsuitable; in such a place a beech is planted. Also, an ash is planted instead of an oak wherever the ground is more suitable for ash.

This method of planting oak and larch mixed should be used wherever the ground gives a fair chance of good growth for the oak. On any part of the plantation which is of better quality pure oak should be planted, and on the part below the average in quality a crop of pure larch can be grown.

In mixed woods, made as above, there is every probability that the oak, protected by the larch, will grow straight and clean, and the larch will be more free from disease than when planted pure.

Mixed planting with larch and oak is done for the benefit of the oak, and is based on two reasons. One is cultural: the more rapid growth of the larch prevents the oak from spreading and promotes upward growth; and the other is financial: the early returns from the larch are some compensation for the long-deferred harvest from the oak. When the land is well suited for oak the young trees start well, grow quickly, and soon close up, and the first reason does not apply. Such land should be planted pure oak. Mixed planting is most useful when the soil is somewhat below, in fertility, what is best suited for oak, and the young oak will probably require protection, and in addition there is a ready sale for larch thinnings. In the absence of such a sale the probability is considerable that the thinnings will be neglected and the larch allowed to smother the oak. Local circumstances can alone show, after careful consideration, whether a proposed plantation should be pure oak or oak and larch mixed, or pure larch, or even Scotch fir; but it will generally be found that the whole wood, or a part of it, can with advantage be treated as a mixed plantation.

In some cases the advantage which larch derive from mixed planting is an important consideration. Larch in this country is more likely to be free from disease and to grow vigorously to complete maturity if it is surrounded by broad-leaved trees. Hitherto larch has been most remunerative when it has been planted pure and felled as a clean-cut at fifty or sixty years. At that age the individual trees have not reached the greatest growth of which they are capable under favourable circumstances.

The object sought has been to obtain a large amount of cubic feet of timber in the wood, and not large trees; but the timber from trees fifty or sixty years old is less hard and durable than that supplied by trees of a greater age. It is possible that, in the future, as a result of great destruction of timber during the war, there will be a considerable appreciation in the value of larch from which 9 or 12-inch planks of hard durable timber can be cut. The best way to grow trees of this size is to plant a mixed wood, principally with a view of growing oak, to thin the larch vigorously even at a financial loss, and to leave a residue of the best larch to remain with the oak for eighty or ninety years. The enchanced price per cubic foot may be a sufficient compensation for the delay in the returns from the larch, but as the enhancement is only conjectural it would be hazardous to sacrifice in the management the oak for the larch.

In a wood where the number of larch is so great in proportion to all other trees that it is substantially a pure larch wood, the introduction of a few broad-leaved trees can have little effect in preventing injury by disease. Broad belts of such trees might prevent injurious spores from being blown by the winds from diseased trees to fresh spots, but they would occupy a large amount of ground and diminish the returns which the planter had hoped to receive from a pure larch crop.

A plantation of pure larch is advisable when the ground is unsuitable for oak, or financial reasons make quick returns imperative. In this case the risk of disease must be faced. It cannot be overlooked, but it is possible to exaggerate it. The liability to disease is always present. Diseased trees can be seen in natural Swiss forests and in the middle of English lawns, but the worst forms of disease occur only in crowded artificial plantations. Assuming that the site of the plantation is suitable for larch, disease can be kept in check by free circulation of air, and this is possible if the trees are properly thinned.

A pure larch wood, if exposed to gales, must be protected by the introduction of some broad-leaved trees, either singly or in groups. Few of these trees grow into good timber, but the cost of planting them is well repaid by the protection from the wind which the larch derive. Beech and sycamore are quite as good as oak for giving protection against the wind, and will thrive on poorer soil. The advantage of planting oak, where it is possible, is that the planter has the chance that some of the oak may become remunerative timber, and also the oak may be useful for natural regeneration after the removal of the larch. The introduction of broad-leaved trees into what would be, if they were absent, a pure larch plantation, can only be justified financially if the situation is such that a few trees can protect from wind a large area. If a large extent of ground is occupied by such trees, the protection which they give has been bought too dearly.

A large plantation of pure larch gives a planter almost his only chance of a fair remuneration in his lifetime for his outlay. The risk from disease and gales is inevitable, but it may be reduced by choosing a favourable site, with free drainage, ample circulation of air, and protection from gales.

Damp or confined positions in a pure larch plantation should be planted with those trees which thrive in these situations. Any land which is unsuited for larch on account of sterility of soil, altitude of situation, or exposure to violent gales, should be left unplanted by any one who plants with a hope of profit.

The selection of the best tree to plant after a crop of pure larch is a serious difficulty. There are instances where a second crop of larch has grown well, but they are rare. Most larch plantations planted after larch either die off when they are about fifteen years old, or else suffer from heart-rot to such an extent that when they are felled it is possible to push the handle of an axe up the centre of the tree.

The planting of an oak wood after a crop of pure larch would be a doubtful experiment. Thus both oak and larch are excluded.

Two suggestions may be made. First, postpone replanting for ten or twelve years, and in the meantime use the land for a sheep-run, and then replant with another crop of pure larch. Secondly, where it is not desirable to open the land to sheep—as, for example, when it is part of a larger wood—try the experiment of natural regeneration. Unless the circumstances are very unfavourable a certain number of hardwood seedlings will appear on the ground; these should be protected by cutting back any briars or bushes which encroach on them. When these natural seedlings have established themselves, gaps in the crop should be filled by transplants, special care being taken that ash are planted in any spots that are suitable, oak wherever growing oak seedlings indicate a fair chance of success, and the rest of the wood filled up with beech and sycamore.

Experience shows that, in mixed woods of larch with oak, beech, or sycamore, the larch have greater vigour, resistance to wind, and more freedom from disease than in pure larch woods; also that larch generally does not succeed as a second crop after larch. It is difficult to assign satisfactory reasons for these facts. Possibly broad-leaved trees offer less resistance to currents of air than larch, and if this is so, their presence would be an aid to ventilation of the plantation. In late growth, when the trees stand somewhat apart, the advantage given by the broad-leaved trees is probably due to their leaves, which quickly decay and so keep the soil more cool and open than it would be if either covered with larch leaves or bare and swept by winds. Agriculture shows that after successive crops of the same plants the soil loses something which is essential to healthy growth. In the forests of Switzerland larch can grow in large pure woods and maintain itself continuously by natural reproduction, but in England the susceptibility to disease and the inability to reproduce itself by natural seedlings indicate that there is a diminution of vitality in the plants and that the climate and soil are less suitable than in Switzerland. The comparatively high winter temperature and the dampness of the English climate induce a quicker growth than on the Continent, and this quicker growth may impose so great a strain on the soil that soil exhaustion in England is in a few years greater than after centuries in Switzerland. Also, the climate of England may be advantageous to some destructive spores which exist in the soil or stumps of a felled larch wood. Very little observation on this point has been recorded, and it is impossible to say what is the least period during which the site of a previous larch wood should remain unplanted, or to indicate any effective and practical methods for shortening this period.

NOTES ON PARTICULAR TREES

CHAPTER IV

NOTES ON PARTICULAR TREES

THERE are two varieties of oak in English woods, the pedunculate and sessile. In the pedunculate variety the acorns are borne on stalks and the leaves are either sessile or borne on very short petioles. The leaves of the sessile variety are borne on a petiole nearly half an inch long, and the acorns are sessile. It is probable that there are some sub-varieties, for it is not uncommon to see in woods of pedunculate oak some trees which are conspicuous by the smoothness and light colour of their bark and other trees whose leaves are borne on long petioles.

The pedunculate variety is by far the most common, and it is generally believed that most of the famous old oak trees were of the pedunculate variety.

The varieties of oak do not, so far as is known, possess any difference in the quality of the timber, nor is there any difference in the price realised. It is impossible to determine, once a tree is felled, whether it belongs to the sessile or pedunculate variety. Unless the intended plantation is in a district where the sessile variety grows well, the pedunculate variety should be planted, for if there is any superiority in use for structural purposes and durability it belongs to the pedunculate variety.

Oak timber of the finest quality is nearly always found only in trees which have grown isolated or as standards over coppice. Such trees will usually have short boles and large branching heads, but occasionally, and on land particularly suitable for oak, they grow as vigorous trees, with tall clean boles, and the timber from such trees is of exceptional size and quality.

Oak woods have generally been formed by planting, but some have been formed by ploughing the ground and sowing acorns. It is not probable that sowing has any advantage in point of economy over planting.

This method of growing oak was probably adopted in deference to an opinion that oak grown in situ made better timber than trees which had suffered the check of being transplanted. There are no experiments from which it is possible to decide if there are any grounds for supposing that trees grown in situ from acorns do in fact make better timber than transplants. The disadvantage of forming oak woods by the sowing of acorns is, that it is difficult to preserve the acorns in a large plantation from the ravages of mice and other vermin, and unless the seedlings are cleaned by hoeing they are in great danger of being smothered by the grass.

Oak does not generally grow to much value on poor land. It should not be planted on any soils except those which are somewhat above the average quality found in plantations, or on which there has been a previous crop of fair oak.

In the West Midland counties along the Welsh border there are many thousand acres of self-sown oak woods on stony hill-sides, nearly all of the pedunculate variety. The boles are of fair height, free from boughs, and the timber is of excellent quality, but the trees are small in size—one of 11 inches quarter-girth under bark is above the average. There is no wood which now sells so badly as small-sized oak. These woods rarely produce an annual gross income of 4*s*. per acre, 2*s*. 6*d*. to 3*s*. is as much as most of them produce. It is hard to see, while prices remain at their present low level, any remedy for this poor return. These woods have no annual expenditure except the maintenance of the fences and the payment of rates and taxes. Any change in their condition, such as clear-cutting and planting the cleared site with larch, would involve considerable expense, therefore probably the best plan of management is to leave them for the present unaltered. A rise in the price of second-class oak timber or of oak bark, or a revival of charcoal burning, might make them more remunerative.

Good loam such as is suitable for tillage, if free from any stagnant water, is the best soil for oak, but fine oak is not confined to such land. There are several districts in England famous for the excellent quality of the oak grown in them, and some of these have a sandy soil. Some light soils burn up in a hot summer and could not grow fine oaks, while other light soils are always cool. Gravelly soils would probably be unsuitable, and clay soils would probably be suitable, unless they were liable to crack in summer. These probabilities should be considered before a decision to plant oak is made, but the past history of the land, when attainable, gives a much better notion of its suitability for growing oak than can be gained by inspection of the soil.

In the southern counties the sessile variety is said to grow more freely and with greater length of stem than the pedunculate variety on light gravelly land, but to be more liable to shakes.

Ash is the most remunerative tree grown in English woods. It commands a ready sale and good prices. As a rule it grows well and seeds itself freely in any soil which is of fair fertility and damp, if free from sourness and under the 800-foot contour line. Some very fine trees are found on limestone formation, but more usually it grows quickly where there is lime, until it is fifty or sixty years old, and then is checked and becomes liable to decay. If ash on limestone is cut down as soon as growth slackens, the timber is usually of excellent quality. It is a capricious tree, and sometimes refuses to grow well on land which seems suitable for it. It generally grows scattered among other trees in a wood, or in small groups on banks in pasture lands, or as hedgerow timber. It is rarely seen in large groups or in pure woods. The seed (called keys) germinates in the second year after it is formed. It is kept, mixed with sand, during the first winter and sown in the following April in beds 4 feet wide. The young seedlings bear transplanting very well. In every wood, where the ground is suitable, some ash should be planted. After the early stages of growth ash requires ample space, and at every thinning should be freed from the encroachments of the adjoining trees. Fifteen feet is the minimum distance apart of ash 25 feet high, unless the situation is exceptionally favourable and the trees have strong as well as tall, clean boles. When the trees have finished height-growth they should be at least 20 to 24 feet apart. There is a strong belief among woodmen that self-sown ash are not so liable to be bitten by rabbits as transplants.

Among the poplars the variety sold by nurserymen under the name of Black Italian seems to have entirely superseded the English Black Poplar, as being of quicker growth and improved quality. It is a tree of extraordinary rapidity of growth, and attains great size. The timber is soft wood, but it is strong, does not splinter, nor easily catch fire. It is very useful for inside work, such as flooring, as boards for railway wagons, or as wooden breaks and packing-cases. It grows in damp soils, requires an ample quantity of space, and likes a limestone subsoil. Its defect from a financial point of view is that, unless it grows in an easily accessible place, the great size makes the cost of haulage extremely high. A butt weighing many tons cannot be hauled out of a hollow or across soft ground without great labour. In such cases the haulage may cost the timber merchant as much as the tree. On damp ground adjoining a road Black Italian Poplar planted 10 or 12 feet apart would be a very remunerative crop.

Alders, whether they grow naturally by the side of streams or as planted trees on the damp spots in plantations, are a remunerative crop in any district where clogging is practised. They grow fit for the market in twenty-five or thirty years, and occupy ground which otherwise would be worthless. The cost of haulage is slight, therefore they can be sold profitably though growing in a situation where in the case of other trees the cost of haulage would be almost prohibitive. The reason of this ease of haulage is that they are converted near the wood and the setts are stacked and allowed to dry before removal, and thus there is no necessity to remove superfluous weight or bulk.

Another advantage of alder is that they reproduce themselves freely.

Beech, by the custom of the county, is timber in Buckinghamshire. The large beech woods grown on the chalk hills supply the timber for the kitchen chairs and furniture which are made at High Wycombe and the villages near the woods. These woods are managed on the following system: Each wood is visited every eight or sixteen years, or some other regular time. All the mature trees are then felled and the other trees thinned. Every portion of the wood has on it trees of every age in regular gradation, and the cutting is managed so that as an age class grows older its numbers become less. The grandfathers of the wood are cut out to make way for the fathers who, in their turn, become grandfathers. The trees are very largely self-sown. Sixty to eighty years are the periods of growth. These woods can, under careful management, produce a regular income of £1 to 30*s*. per acre.

Outside Buckinghamshire there are few woods of pure beech, and the prices for beech timber were prior to the war generally unremunerative. The merit of the beech, from a planter's point of view, is that it will grow in the shade of other trees and therefore can be planted to supply the place of natural underwood where that fails.

The value of the beech for sylvicultural purposes has been placed very high by continental professors of forestry. It has been said to protect the fertility of the soil by its close canopy, and to increase it by the fall of leaves of considerable manurial value. If it could be proved that by underplanting with beech, good oak could be profitably grown in England, on land which otherwise would be of insufficient fertility, it would be necessary to concede these claims. The differences between the conditions in Germany and England are so great that it is only with great caution that practices usual in Germany can be applied usefully here. In a great part of Germany the soil is sandy, and the climate very dry in summer. Here sandy soils are the exception, and the climate is damp. Here, when oak woods are partially cleared near the end of the rotation, the soil is soon covered with a natural crop of hazel and oak bushes which can be sold as crate-wood, but if this natural underwood fails to appear, or there are places which have become vacant by the death of trees, under-planting with beech may be useful. In two other cases beech may be profitably planted under other trees. Where there is an exceptionally good sale for immature larch and the owner is unwilling to clear-cut and replant, he may severely thin, to the extent of two thirds or more of the crop, and then fill up the wood with beech. The soil would probably become dried and impoverished unless it was protected by an under-growth, and natural undergrowth would probably not come in a larch wood severely opened out. An oak wood of thirty or forty years which flags because the ground is not quite good enough for it may also be benefited by a severe thinning and underplanting with beech. The leaves keep the ground clear of weeds and the stems shade the stems of the oak and prevent the growth of lateral boughs.

Severe thinning followed by under-planting with beech is an expensive and rather risky experiment. There is the risk of damage by wind, and also the risk that the reduction in the number of the trees may not be repaid by a sufficient enhancement in the size and quality of the remaining trees. The under-crop may grow so freely as to deprive the first crop of sufficient nutriment. The propriety of under-planting with beech can be decided only after careful consideration of the crop, soil, and future market price of each wood. The financial return from beech planted as an under-crop will generally be small. If felled at the same time as the first crop, they will probably be small-sized; if allowed to remain, they will have been so much damaged by the felling of the first crop as to be of little selling value.

There is no doubt of the benefit given by beech leaves in keeping the soil of a wood cool and free from weeds; their manurial value has not been proved.

Beech is not an easy tree to plant in a new wood. The young trees suffer from exposure to the sun, and a hot summer kills many of them unless they are protected by the shade of older trees.

The value of the beech tree to the English planter who lives outside the counties where there is a local industry in beech, is that it is, with the exception of silver fir, the only shade-bearing tree which he can plant.

Sycamore, when sound, clean, and of large size, is a valuable tree, but in ordinary sizes and with boughs on the stem it is almost unsaleable. Thinnings are worthless, the value comes only from the final fall. The hardiness of the tree and the ease with which it can be raised from seed make it useful for filling up any small patch in a wood, on which it is doubtful if other trees would grow. It will thrive on any soil or situation that is likely to be found in a plantation. It is an excellent tree for shelter; it stands the wind well; the leaves do not cast so deep a shade as beech; self-sown seedlings of oak and ash are not smothered by it. Almost every year a sycamore growing in the open has a good crop of keys. These, if gathered in October and November and planted in rows in a garden in 4-foot wide beds, produce several hundred seedlings at a nominal cost. In the second April after sowing the seedlings should be transplanted in rows 15 inches apart and 4 inches apart in the rows. In two or three years later they are fit to be planted in the woods. Although sycamore is generally not a remunerative tree, it is useful for planting to a limited extent.

Elm has two main varieties, the small-leaved, called the English elm, and the large-leaved, called the Scotch or Wych elm. The English elm seeds either not at all or only on very rare occasions; it is propagated by suckers. The

Wych elm seeds and has no suckers. There is a bewildering number of sub-varieties. Every kind of elm is better adapted for hedgerows than for planting in woods. In most years elm has a very poor sale, if offered in large quantities. However, in some localities there is a good sale of limited quantities for local use, if the haulage is easy. As a remunerative sale of elm is generally strictly local, that kind should be planted which the local wheelwrights prefer.

The main point of interest about larch for a planter is the difficulty of growing it free from disease. In the early part of the last century millions of larch were planted, particularly in Scotland and in the counties of Cumberland and Westmoreland. If these woods had grown to maturity in a healthy condition, or if it had been found profitable to grow successive crops of larch on the same soil, it would have been proved that timber-growing in England could be highly successful. Even now, after taking into consideration the grave risk of disease, it is probable that in most districts larch is the only kind of tree which can be grown to a profit in large plantations. So that in most cases, if financial considerations are important, the alternative is either to plant larch or not plant at all.

The risk of disease can be materially reduced by the choice of a situation suitable to larch and by securing, through thinnings, a free circulation of air in the plantation; as to which, see p. 33, *supra*.

Larch grows best in situations which are slightly damp and where the soil is freely porous, as on banks. The quality of the land should be similar to that of a fair hill sheep-walk. Rich ground is apt to produce timber of a soft, spongy quality, susceptible to disease. Dry land facing the south would in most cases be so liable to be burnt in a hot summer that it would be hazardous to plant it with larch. Land covered with heather rarely produces a satisfactory crop. Two situations are almost certainly fatal, namely, damp ground on a water-logged subsoil, such as is frequently found on the flat top of moorlands, and low-lying ground liable to mist and late frosts in spring and to a damp warmth in summer.

European larch is grown from seed collected either in the United Kingdom or on the Continent. Seeds from Switzerland and the Tyrol are preferred to seeds from Scandinavia and Germany. In the hope, that seeds taken from vigorous trees growing at moderate altitudes in the native forests of larch would produce trees of great health and resistance to disease, many persons have sown larch carefully collected in Switzerland or the Tyrol, but the results have often been indecisive. There is little information about the influence which the seed has on the future tree as regards health, rapidity of growth, and quality of timber. There is no consensus among planters that there is any proof that Continental is superior to native seed, and it is believed that nurserymen, a class whose practical knowledge makes their opinion valuable, consider that better trees are produced in England by English and Scotch seed than by Continental seed.

Japanese larch are not immune from disease, but they seem to have justified the claim that they are less susceptible to disease and in early life, at least, have a more vigorous growth than European larch. The seedlings are more expensive than European larch, and they are more liable to be killed by a prolonged drought. The value of mature timber grown in England has not yet been ascertained. Therefore, until further information about it is available, this larch should be planted only experimentally by an English planter, or when there is some reason for thinking that European larch would not succeed.

Douglas fir is the most promising of the more recent introductions. It grows quickly and to a great size. The only known defect is that it has a poor resistance to the wind, and when it grows above the level of a plantation is liable to lose the leader. The value of the mature timber has not yet been proved in the market. There are in England a considerable number of old trees, but it is believed that no mature plantations of Douglas fir have yet been offered for sale to timber merchants.

Douglas fir requires a soil slightly more damp than what is best suited for larch, and a position free from strong winds. The growth is very doubtful in a wet situation or where there is limestone. The trees should be planted at least 6 feet apart and thinned heavily during the last years of the pole stage.

There are two varieties, the Oregon green variety, usually planted, and the Colorado or glaucous variety, which is much slower in growth than the Oregon, but is said to stand the wind better.

Scotch fir are capable of forming very large pure woods self-sown, and examples of such woods can be seen in Surrey. A great part of that county consists of large and extremely barren commons of heather and sandy soil. As long as cattle browsed the commons, no trees could grow in any numbers. During the last century the neighbourhood of London made a great change: villas replaced cottages and poor farms became residential properties. The habit of pasturing cattle on these barren commons greatly decreased, with the result that an amazing growth of young fir trees sprung up as soon as they were no longer browsed by cattle.

Scotch fir woods stretch for miles from the neighbourhood of Sandown racecourse. The ground under the trees is covered to the depth of some inches with a deposit of fir needles; sometimes not a blade of grass is to be seen. The trees are close together, with clean boles and no side branches.

The state of these woods show that Scotch fir can grow in perfect health when the trees are not thinned artificially but allowed to thin themselves by a struggle for existence.

Scotch fir sells for a poor price, unless the wood has a cheap haulage to a colliery so that it can be sold for pit-props.

Scotch fir of about sixty-years growth or less is coarse-grained and poor in quality. Lengthening the rotation to eighty or one hundred years produces a considerable improvement in the timber, but even then Scotch fir grown in England is not more than equal to average foreign deal, and the price does not compensate for the length of the rotation.

Planting Scotch fir cannot be recommended. The price is unremunerative; the tree is very liable to be broken by the snow. On sandy soils there is the grave risk of destruction by fire of the young plantation. The ground is covered with a dry herbage, which is very inflammable, and a fire in a young Scotch fir plantation is unmanageable.

If it is decided to plant Scotch fir care should be taken that the seedlings should be grown from seeds collected in Scotland. The English and Continental varieties produce timber distinctly inferior to trees grown in Scotland.

A self-sown wood of Scotch fir on poor land costs nothing, and therefore is an advantage to the owner of the land, even if the financial returns are slight. It is better than the poor herbage which preceded it. Special circumstances, such as a good market for pit-props and a cheap haulage, may justify the expense of making a plantation. A few Scotch fir in a wood are an ornament in winter when the other trees have lost their leaves, and give a warm shelter to game. It rarely produces in England timber capable of making good planks and beams until it is much older than larch of the same size would be. As a rule, a larger profit will be made by selling a wood as soon as it is fit for pit-props and poles than by thinning and allowing the best trees to remain to form large timber.

Spruce is liable to be blown down in gales, for the roots are close to the ground. It is not often injured by snow, for the boughs bend under the weight and allow the snow to slip off. The timber generally sells better than Scotch fir. It may be usefully planted in sheltered places which are damp and not good enough for ash, and sometimes in such situations it grows to a great size.

Sitka spruce is a faster growing tree than the common spruce. Although the value of the mature timber has not yet been proved and it can be planted only as an experiment, yet it offers a reasonable prospect of being remunerative if it is planted as an alternative to alder or Black Italian poplar where the local circumstances make the planting of either of these undesirable.

Corsican fir is a tree which has obvious disadvantages. It is difficult to transplant; heavy losses are frequent. The timber is coarse and hard to work. It can be planted usefully only in exposed positions as a wind-screen. It is very hardy when once established.

Silver fir bears shade well, grows quickly, attains a large size. It offers no attractions to timber merchants, and is a most unremunerative tree. The forests of the Austrian Tyrol and Styria were originally almost entirely silver fir. Spruce has been introduced as more remunerative. In these countries it is usual for the timber merchants to require a guarantee that not more than 20 per cent. of the crop is Silver fir. Under the most favourable circumstances the quality of the timber is poor. It was introduced into England three hundred years ago. It has never been planted to a large extent. From the difference of the botanical names, *Picea excelsa* (Spruce) and *Abies pectinata* (Silver fir), it is apparent that botanists can observe some marked difference between them, but to most people they appear to be very similar and not more distant from each other than varieties of the same species.

It would be tedious to discuss the different kinds of coniferous trees, seedlings of which are offered in the nurserymen's catalogues. Some of them, like Weymouth pine, have been known for many years, and others are of more recent introduction. A planter to whom financial considerations are of importance should confine himself to those trees which experience shows grow well in England, and produce timber attractive to timber merchants. Other trees should be left for the plantations of rich men who are patriotic enough to make experiments for the benefit of posterity.

PLANTING FOR SHELTER

CHAPTER V

PLANTING FOR SHELTER

THE climate of a country is principally due to causes which cannot be modified, such as the distance from the equator, the prevailing winds—which may be scorching, genial, or cold—and to the elevation above sea-level. In addition to these causes, there are some subsidiary causes of climate which can be modified. Among these secondary causes forests are very important.

Forests, by their leaves, protect the soil from the sun and from rain. They act as a covering between the sun and the soil, so that during the day the heat is hindered from reaching the soil and at night the radiation of heat from the soil is less than when the soil is unprotected. The leaves also protect the soil from being splashed by the rain. The dead leaves and vegetation act as a sponge: they absorb a considerable portion of the rain and release it gradually.

In some countries the rays of the sun strike the ground with great heat, and the rain during most of the year is entirely absent and for short periods falls in torrents. On the hill-sides of such countries, if there are no forests, the soil is baked dry by the sun; and when the rain falls torrentially, it washes the soil into the valleys. In the absence of woodland areas which could retain the water and release it gradually, the rivers are generally empty, and when the torrential rains come they are turned into floods, which disappear shortly after the cessation of the rains.

Woods are beneficial to the climate in any country where the sun's rays are very strong and the rain falls at long intervals and in torrential downpours. They are injurious if the warmth of the sun is less than is desirable, and there is a regular and excessive rainfall.

Northern Africa and parts of Syria are instances of countries whose climate has been injuriously affected by the removal of forests. There are also instances of benefits derived from the removal of forests. The barbarians who attacked the declining Roman Empire are recorded to have frequently crossed the Danube and the Rhine with their wagons on the ice.

These rivers are now frozen across only at long intervals. There is reason to believe that the climate of Germany is now much warmer than it was in ancient times. The removal of the forests has allowed the rays of the sun to reach the soil and warm it.

In the British Isles it is unlikely that forests can produce any general effect on the climate, nor is it desirable that they should have any such effect. The soil requires no protection from the rays of the sun and the heavy rainfall preserves the springs without the assistance of forests. No injury to the general climate is to be anticipated from an increase of woodland area; but in those hilly situations which are naturally inclined to suffer from rain, large plantations may locally have an injurious effect by lowering the temperature and increasing fog and dampness.

In this climate woods have a great value in some cases, because they ameliorate local conditions by giving a protection against the force of the wind. On many hill-sides the sheep spend most of their time in a gale of wind. A substantial protection from the wind increases the health and comfort of the sheep and gives the more nutritious grasses a chance of growth.

On hill farms judiciously planted woods mitigate the cold and prevent the crops from being flattened by the winds.

Woods planted on hill land for shelter can hardly be expected to produce remunerative timber, especially if they are above the 1,000-foot contour-line. The conditions are not favourable to the growth of trees and the cost of haulage is generally very high from these woods.

Very commonly long narrow belts, composed principally of conifers, have been planted for shelter. These belts are extremely ugly, and the cost of fencing is excessive. The shelter from the wind which they give is very little. Instead of giving protection they have the appearance of requiring protection. Many of the trees die, and the rest are sickly and stunted. There is no reasonable chance of growing remunerative timber in narrow belts.

If an owner decides to incur the expense of making a narrow shelter belt, beech is the best tree to be planted. In case the beech do not grow, sycamore may be used. Beech are very hardy, and if their fences are allowed to go down as soon as the trees are safe from injury, the sheep and cattle find under their boughs a pleasant shade from the flies in summer and there is some protection from the wind.

Larch, if planted in a shelter belt, should be thinned until every tree stands isolated from his neighbours. Trees grown in this way develop strong roots and side boughs, so that they are well anchored and form a good wall against the wind.

The advantage of beech over larch is that they live longer. Beech belts planted in the early years of the last century are still vigorous at 1,500 feet above sea level. Scotch fir should be avoided on account of their liability to be broken by snow.

The benefit given to the adjacent land by well-planned plantations is most obvious on hill-land, but there are few situations where the comfort of the live stock and the security of the crops does not, to some extent, depend on protection against the wind. On flat lands the winds blow with great force and keenness, and if they are not checked by trees and plantations they may have a very injurious effect. A narrow depression in the land sometimes acts as a funnel, and even a moderate wind rushes down it. In such a case a plantation at the top of the depression may materially improve the temperature of the lower land.

Caution must be used in making plantations on low land, for shelter from the wind is not always desirable. Drying winds are often beneficial; if they are excluded and the sunlight obstructed, damp land may become sour.

FINANCE

CHAPTER VI

FINANCE

A QUESTION that is frequently asked is, "Does timber-planting pay?" Without an explanation of what is meant by the question it is impossible to give a clear answer, and yet the hesitancy to give a clear answer is taken often as an admission that timber-planting does not pay.

In the financial papers one may occasionally see the expression that at the present rate of interest it does not pay to invest in the ordinary stocks of English Railways. In this context the expression means, Is it not possible to find other investments which are equally safe and yet produce a higher rate of interest? If the expression is used in this sense about timber-planting the answer must be in the negative. Timber-planting, with the best fortune, can produce only a low interest and it is not a safe investment. The trees are exposed to the vicissitudes of weather and fire, and their realisation is difficult and purely speculative, for no one can say with certainty what will be the price of timber many years hence.

The views expressed in these pages are: First, the future will show no substantial difference in returns from the past; any difference in prices will probably be counterbalanced by corresponding differences in the cost of labour and public burdens. Secondly, timber-planting can only in very rare cases show a financial result which a chartered accountant would accept as a profit. In spite of these disadvantages, timber-planting has two considerable advantages, which, however, cannot be realised unless the woodlands are managed with great economy and unless they are in private hands, so that a large proportion of the supervision is given by the proprietor and not charged against the woodlands as an item on the debit side of the account.

Assuming the conditions of economy in management and partly unpaid supervision, woodlands are a convenient form of accumulation at a moderate rate of interest, and also they provide a useful means for the investment of small sums which otherwise might be wasted.

Very few persons would be content to invest their money in shares of a company formed for the purpose of buying land and planting on it. During the growth of the trees there would be no dividend and constant expenditure, and this period of postponement of dividends might last for sixty or eighty years.

Therefore it must be admitted that timber-growing does not pay, if the question means, Does it produce a high rate of interest, or is it attractive to an investor who wishes to have a safe income?

Timber-growing, however, pays well if it is regarded as a form of accumulation. It is free from those practical difficulties which frequently make the results of accumulation far less than might be anticipated from a consideration of the mathematical results of compound interest.

Many testators have directed by their wills that sums of money should be accumulated at compound interest. The result has nearly always disappointed their hopes that there would, one day, be a fund approximately equal to the sum shown in interest tables as due from compound interest at a moderate rate.

It is in practice impossible to invest dividends immediately on their receipt. There are always expenses of taxation, stamps, commission, and brokerage. There are also difficulties in finding suitable investments.

Well-planted and well-managed woods save their owner from the usual misfortunes that attend the accumulation of small yearly sums for long periods. They incur no broker's charges or commission. The yearly increment of the woods is stored in the trees themselves, so that there is not the difficulty of continually finding new investments for the income received. The trees grow without labour by the owner, and in addition to any financial gain he has the satisfaction of having fine woods, the result of his own careful management.

Trees have the disadvantage that they are liable to destruction by fire, storm, and disease, but there can be no form of investment which is free from all risk; all that is claimed for timber-planting is that as a method of accumulation it compares favourably with any other form.

A landowner who succeeded to an estate in early life as soon as he reached his majority planted with pure larch an area comparatively large for the size of the property. The plantation grew well, and when the trees were fifty-five years old they were sold and the proceeds realised some thousands of pounds. Mathematically considered the transaction was a fair success, commercially considered it was a very great success. The owner received a sum vastly greater than it is probable that he would have made if he had tried to accumulate in securities for fifty-five years the expenses attributable to the planting.

Planting has also other financial advantages. It is a ready way of employing usefully small sums which a landowner would not trouble to invest, and which if not used in planting might very probably be wasted. Men engaged in planting are often required on an estate in other ways, and planting gives them occupation during many months when it would be otherwise difficult to find them work.

Accumulation, in the form of tree-planting, can be profitable only if the length of the rotation is not excessive taking into account the price ultimately realised. In a long rotation the expenses accumulate to a large amount, and unless the prices realised by the mature timber are high, it may possibly be that instead of a profit the expenses overtop the receipts. In a short rotation success is possible, even if the prices are low, but in a long rotation high prices are essential.

At present prices, larch with a rotation of less than seventy-five or eighty years may be a profitable form of accumulation.

Oak woods requiring a rotation of 120 or 150 years may pay if there should be a considerable rise in the price of oak timber. At present prices the expenses will during the rotation accumulate to a much greater sum than can be realised by the sale of the timber.

A timber planter has also this advantage over other investors, that his capital is not likely to depreciate violently. The fall in the capital value of all first-class investments has been remarkable. Some authorities whose opinion is entitled to respect have expressed the opinion that a serious rise in the price of timber is certain. The opinion is founded on the expected arrival of a timber famine and on the regular appreciation during the last fifty years of timber in the markets of the world. Unfortunately there are some considerations which diminish the probability of much rise in price. A timber famine has often been predicted and has never yet come. It is true that the consumption of timber greatly exceeds the growth in the forests which are now commercially accessible, but it is possible that greater economy of conversion, or the substitution of metal work for timber, may enable the supply of timber to satisfy the demand. Any invention which reduced the cost of transport would open to the commerce of the world enormous forests in America, Russia, and Siberia. Even if for the sake of argument it is admitted that the supply of timber will diminish and a rise in the price follow, it would remain uncertain, how far this rise will be counteracted by the tendency of modern legislation to increase the taxation of land, and how much of any increase in price will be taken by the feller, the hauler, and the timber merchant, and what will be left for the grower of the trees. The conclusion to be gained by a consideration of all the probabilities seems to be that a serious fall in the price of timber is improbable, and that a planter may, without being unduly sanguine, entertain some expectation of a rise.

But even a large rise in price does not necessarily mean a large increase in the profits of a timber grower. In February 1917 the Government paid 6*s.* or 7*s.* per cubic foot for sawn oak planks, and 1*s.* 9*d.* per cubic foot for oak trees identical in size and quality with the trees from which the planks were sawn. From this example a planter can see that the grower of timber may sometimes have a very small share in an extraordinary rise in the price of converted timber.

In timber-planting there is, on the debit side of the account, a large initial cost for planting, an annual loss of the land, and an annual expenditure for maintenance, rates and taxes, while the receipts are many years later in date than the main part of the items on the debit side. The accounts are made either by reducing all expenses and receipts to their present value at a selected rate of interest as at the date of the planting, or all expenses and receipts are reckoned at compound interest until the date when the wood is finally felled. The profit or loss may be shown either by the rate of interest selected or by the difference between the incomings and outgoings reduced to the same moment.

There are various mathematical formulæ for finding the net financial result of timber-planting. These are valuable in an inquiry into the past financial history of a wood if all expenses and receipts from planting to the final fall have been carefully recorded. When they are used for calculating the probable future result of planting a wood they are of only slight value. All future receipts, expenses, and rates of growth are uncertain. The figures for them stated in the accounts are at the best only probable guesses. The mathematical accuracy of the process gives a false air of real accuracy, for it tends to conceal the fact that the whole reasoning is based on guesses and not on results.

Accounts of profit and loss in timber-planting have probably very little influence on most owners when they consider a plan of timber-planting. They recognise that as regards themselves personally these accounts are of no value. There is so little probability that their life will extend to the maturity of the trees, that for them there can be no items on the receipt side of the account.

In most cases the planter is willing to consider the initial cost of planting as a loan by himself, free of interest, to the wood. When the land planted is the site of a recently felled wood, it would in most cases be unfair to charge in the accounts of the new wood an agricultural rental for the site, because the cost of making such land capable of producing any agricultural rent is almost prohibitive.

The future history of an intended plantation can only be told by the past history of other plantations grown under similar circumstances.

It may be assumed that the intended wood will not be more successful than the most successful wood of the same class which is known to have grown within one or two miles of it. And, taking this known wood as a maximum, from a consideration of site, soil, situation, and exposure, a fair guess may be made about the final crop of the intended wood.

Planting a piece of land which is not known to have previously produced a successful crop of trees, and is more than a few miles distant from any similar piece of land which has produced such a crop, is experimental.

The difficulties which a planter has in attempting to forecast the result of planting may be realised by comparing his position with that of a farmer. The advantages which the farmer has are very great. He knows the average crop that the field has yielded and the time of harvest, the only important point which is in doubt is the market-price of the produce.

In case of planting trees which, like oak, take at least a century to mature, it is useless to make any forecast about the result of the planting. The changes which a century will bring are incalculable. Oak planting is justified by considerations which cannot be expressed in figures, such as belief in its rare qualities and a hope for improved prices in the future.

In the case of planting larch, it is possible to make some approximate guesses about the date of harvest and amount of produce, and it is not unreasonable to assume that the market-price of the produce will, when the plantation is mature, be at least no lower than it is now.

There are no statistics available to show the date of the maturity of larch or the quantity of timber or the profit likely to be produced under average circumstances by a larch wood in England; and considering the great variety of conditions of soil, situation, haulage, and market, it is probable that statistics of the average plantation would prove very little about any particular plantation. The public journals frequently publish accounts of profits made by timber-planting, but these refer to successful plantations and no mention is made of failures.

As a rough approximation to truth it may be said that most larch plantations cease to grow vigorously after about fifty-five years. Many grow to seventy years, and some exceptionally good trees in favourable situations are profitably left to ninety or one hundred years, but fifty-five to sixty-five is in most cases the age at which a larch plantation should be felled.

It is impossible to attempt any average statement of the value of thinnings. Generally it is impossible to sell them except locally, and local markets vary extremely. Also there is no distinction between the later thinnings and a partial clearance or the removal of the final crop in instalments.

As a very general statement it may be said that an average larch plantation should yield during the last fifteen years of the rotation a total crop per acre of about 1,600 cubic feet, excluding all trees which measure less than 6 inches quarter-girth under bark.

Probably most planters would be satisfied if they could be sure that at the end of the rotation the receipts would show an annual profit of 8*s.* per acre in addition to 3 per cent. compound interest on the cost. Apart from any local circumstances which may affect favourably the sale of timber, it would be hazardous to plant any land which could be let for more than 5*s.* per acre annually, if the object of the planting was merely the realisation of a profit.

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SYSTEMATIC FORESTRY

CHAPTER VII

SYSTEMATIC FORESTRY

FORESTRY is an art or a collection of rules of applied sagacity. It is incorrect to say that there is a science of forestry. We do not talk of the science of making anything. Success depends on close attention to the different circumstances of each woodland and the application with intelligence of practical rules. Success may in certain cases be obtained by blind unreasoning routine founded on certain traditionary empirical maxims and on mechanical copying of established processes, but under these circumstances success is always uncertain.

The object of this chapter is to show in what way the practical rules of forestry are discovered, and what they are. Forestry is an art which does not admit of a high degree of accuracy, for the conditions under which it exists are ever varying and to a great extent beyond control.

Forestry, like agriculture, is an artificial, not a natural process; but if the forester does not adapt his processes to the laws of nature; if he does not govern his conduct by the climate, seasons, and nature of the soil; and if he does not observe the limits within which the conditions of vegetable life confine his operations, his labour and expense will be in vain.

"There are three primary elements necessary to the success of agricultural operations—skilful husbandry, a well-constituted soil, and a genial climate. The first of these is now placed within the reach of every intelligent man, and depends on the application of his own skill and industry; the constitution of the soil is in general well adapted by nature for the functions it has to perform, and where it is defective its composition may be corrected and its productive powers increased; but the elements which constitute climate appear to be beyond man's control: he is comparatively powerless to mitigate its rigour or to add to its generous influence. It is man's master, exacting submission; not his servant, obeying his behests. Of what avail, then, it may be asked, is the knowledge of such a subject? That we may bend to the power we cannot control, and learn to adapt our culture to the capabilities of the climate; indeed, climate is the ruling principle of agriculture, the law which governs the productions of different countries; and he who yields the most enlightened obedience obtains the largest reward." Whitley, "On the Climate of the British Islands in its Effect on Cultivation," *Journal of the Royal Agricultural Society*, vol. xi., p. 1.[1]

Some woods are successful, possibly in many cases as the result of chance. An investigation into the causes of success is the commencement of a scientific art. The first step in this investigation is that all the facts relevant to the subject are accurately observed, recorded, and classified.

The observations which an individual can make for himself are much fewer in number than those which he can learn from others, but they have the advantage that they are known to him to be perfectly trustworthy. It is unlikely that any responsible person will inaccurately report a fact within his own observation;

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[1] *Methods of Observation and Reasoning in Politics*, by G. C. Lewis, vol. ii., chap. xviii., p. 136. This chapter has a section dealing with the following point, namely, the necessity of limitations does not deprive a subject of a scientific character. In chapter xix. there are sections on the different sorts of art and the relation of art to science.

but if any of the facts are contrary to his own theories he may, very possibly, omit to notice them or pass over them very lightly, and thus give an inaccurate account of the real reason why the wood is successful. If a writer is reporting the success of a wood managed according to a method which he approves, he will almost certainly so represent the facts as to suggest that the method and the success are connected together as cause and effect. Further, except subject to caution, not much benefit can be derived from reading reports about foreign woods unless they are situated in countries whose conditions are fairly similar to those of the United Kingdom. There is always the possibility that the success of any woods in foreign countries may be due to conditions present in those countries and non-existent in the United Kingdom.

The reflections—the result of investigation into the reasons of success—are, when clearly expressed, the practical rules of forestry. The truth of these rules is the result of several sciences, such as botany, chemistry, entomology, and others.

It is no easy matter to say how far a practical man should endeavour to acquire a knowledge of those sciences which prove the truth of the practical rules of the art of forestry.

Some writers claim that a forester ought to make himself acquainted with those sciences which establish the truth of the practical rules of forestry. Unfortunately for this extension of knowledge, the charge of English woods can as a rule claim only a very limited portion of a man's time, and in the more fortunate cases, where forestry is a man's sole profession, he can learn only very little of these sciences, however great his leisure and ability may be.

Nothing can be gained by attempting to place upon foresters such a burden of universal and profound learning that the very enumeration of its kinds is enough to frighten them.[1]

Common sense must decide what can be learnt. For example, a study of botany might require more time than a practical forester might be able to give, but a knowledge of the common plants and flowers might be acquired without much difficulty and usefully.

In almost all cases the practical rules are successful, and it is not necessary to go behind them and to consider why and under what circumstances they are true. When their application does not produce successful results the practical forester should acknowledge the limitations of practical rules, and call in the services of the botanist or chemist or the expert of whatever other science is concerned.

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[1] Sir Joshua Reynolds, *Discourses*, No. VII, and J. S. Mill, *Logic*, book vi., chap. xi., "Relation between rules of art and the theorems of the corresponding science."

In recent years numerous books on forestry have been published in England, and the subject has received considerable attention in the press, in the Journals of Societies, and in inquiries made by Royal Commissions.

A great part of the instructions given by recent writers to owners of English woods consists in a strenuous recommendation to improve their woods by the application of scientific forestry. No definition of scientific forestry is given, but this omission is of less importance than might be expected, for an examination of their works shows that these writers assume that scientific forestry is for all practical purposes the same thing as Continental forestry.

Their views about English woods are fairly unanimous. They consider that they are, speaking generally, in a very bad state, producing a crop hardly equal to half of what it ought to be. This condition they consider to be the result of years of negligence, due partly to a desire to use woods merely as game preserves and partly to the natural stupidity of landowners. The practical remedy suggested is adherence to great and universal truths about forestry which are said to have been discovered in Germany and to have been practised there in the State forests for many years, and as a means thereto the "appointment at Universities, Academies, Institutes, and Forest Schools of many professors of high scientific attainments as teachers of the science of Forestry and the Art of Sylviculture."[1]

There is no doubt that English forestry, like everything else, is capable of improvement, and that academies and professors may be very useful. Still, it is possible to overestimate the advantage of having numerous professors and the inferiority of English compared with German woods.

Speaking generally, the operations of forestry—such as planting, tending the young trees, and thinning—are well understood and properly carried out in England. Mistakes have no doubt often been made.

Over-thinning may have been the practice, but even in this matter there is much to be said on both sides. No definite rule can be laid down. English woods, as a rule, compare favourably with German woods as regards the amount of saleable timber; that is to say, timber which as a minimum squares 6 inches quarter-girth under bark.

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[1] *Studies in Forestry.* Nisbet. Introduction.

In the present day the tendency is to ascribe an almost miraculous effect to science. In the various works which have been written on forestry from a scientific point of view little regard has been paid to the difficulties or the prejudices of English owners. It has been considered sufficient to ascribe any doubts about the value of science to ignorance of what science is and what it has done for forestry.

It is possible that the writers in favour of the claims of science in forestry may have failed to have in their own minds a clear definition of science, and that they may have meant by science merely a knowledge of the natural sciences connected with forestry. The praise of science may be the expression of the benefit which the writers have themselves received in the management of English woods, from a knowledge of the natural sciences. Where this is not the case the advocacy of the claims of forestry may probably be traced to the modern excessive love of government administration. The real, or supposed, necessity of a knowledge of natural sciences is one of the most plausible reasons for the demand that afforestation must be entrusted to a government department whose officials are to be specially trained in a government college.

There can be no useful discussion about the claims of science until there is an agreement about the meaning of science. It ought to be possible for a scientific man to impart his knowledge to the world without depreciation of the labours of the practical man. There is no need for any opposition. The best results will follow when both work in collaboration and assist each other. There is no ground for the supposition that the scientific man should be the teacher and the practical man the pupil.

Forestry is, unfortunately, the art for which the natural sciences are perhaps least useful. The reason is that scientific theories are apt to become detached from reality unless they are tested by frequent experiments, and the long life of trees makes any conclusive experiment very difficult.

Recently a collection of essays has been published under the title, *Science and the Nation,*[1] with the object of making clear the position of research as a factor in national prosperity. One of the essays deals with forestry. The writer admits by implication, that hitherto science (whatever may be meant by this term) has done nothing for forestry, but he is hopeful about the benefits which the student in his laboratory may in the future give to foresters. After a mention of the appalling injuries done to German forests by disease and destructive insects, he suggests that science will be useful in finding means to combat these pests; and further, that science might provide useful knowledge about seeds and the establishment of hybrids.

The writers who advocate science in forestry are also optimistic about the advantages of State afforestation and the profits to be derived from planting. They have one common fault: they urge, perhaps not unfairly, the facts which in their opinion support their argument, but they ignore or press very lightly the difficulties which meet English owners, such as the heavy annual expenses of rates and taxes, the burden of death duties, and the competition of foreign timber, self-sown, and also, as English owners maintain, protected by preferential treatment on English railroads. This one-sided way of stating their case is one of the reasons why they have not succeeded in converting the persons principally interested, that is, the owners and agents of English woods.

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[1] *Science and the Nation,* with an Introduction by the Right Hon. Lord Moulton, edited by A. C. Seward, Master of Downing College, Cambridge. At the University Press, 1917.

The reluctance to follow German methods is not due to want of knowledge of those methods. Members of the Royal Arboricultural Society have visited Germany, and under the guidance of German State foresters have inspected forests. Most English people who possess or manage woods have travelled on the Continent, and it is not to be assumed that during their travels they have kept their eyes absolutely closed. It is at least a possible hypothesis that the omission to follow Continental methods is the result of a reasonable belief that they are unsuited to English woodlands.

Some of the criticism directed against English owners on the ground of their indifference to science and reluctance to follow German methods, may have arisen from political motives; that is, dislike of landowners as a class or an objection to private ownership; but a great part springs simply from a desire to benefit timber growers by inducing them to adopt methods which, so the critics think, will make the woods more remunerative. This is a reasonable object, for hitherto the remuneration of timber-growing has been very slight.

It is obvious that prior to the war there was hardly any remuneration. During the war there was a considerable rise in the prices of timber; but even with this rise the profit does not exceed 4 per cent. on the cost of production. In the opinion of some of those who are most experienced in the sale of timber, the best possible result that can be attained is the sale of a fifty-year old wood at £100 per acre. Many woods have been sold for more per acre; but then, they have been longer in growing, and the net pecuniary result has been worse; also, in every large wood there may have been some acres which were worth more than £100, but other acres in the same wood were worth less.

Assuming that the sale of a fifty-year old wood at £100 per acre is the high-water mark of the possible profits from timber-growing, it can easily be seen what is the difference between the cost of production and the returns. The annual value of land able to produce such a crop would be at least 5*s*. per acre, and the cost of planting £7 per acre. Five shillings per annum for fifty years at 4½ per cent. equals £44·6255, and £7 at compound interest at the same rate equals £63·2282; adding these two sums together the sum on the debit side will be £107 against a credit of £100 by the sale of timber. This way of stating the account assumes that the receipts from thinnings balance the expenditure on maintenance, rates, and taxes; in fact, the thinnings from a wood that at fifty years is sold for £100 per acre can have been very few. An addition must be made to the debit side equal to the excess of expenditure on maintenance, rates, and taxes over the receipts from thinnings. The exact figure of this excess varies according to circumstances. If this excess is equal to as little as 2*s* per acre per annum the net return will be less than 4 per cent. £7 at 4 per cent. compound interest in fifty years equals £49; 7*s*. per annum at the same rate in fifty years equals £53, making in all a debit of £102 against a credit of £100.

The most obvious fault in English forestry is the absence of system. Felling and planting take place at haphazard and not according to a fixed plan. The absence of a system increases the cost of management and prejudices English forestry. Outsiders who notice the absence of system and are ignorant of the difficulties of English owners are apt to assume that this want of system is due to negligence on the part of English owners. The causes are, first, the low prices of oak and coppice woods which have now made their systematic development impossible; and secondly, because, in fact, a regular system is not so essential in England as it is on the Continent.

English owners are not incapable of managing their woods on a very accurate system. As long as coppice woods were remunerative their management was completely systematic. At the present day the beech woods of Buckinghamshire are worked on the selection system, with skill, and produce good returns.

On the Continent the woods frequently are not a part of an estate whose main income is derived from the rents of farms, but are themselves the main estate. Their owner is anxious to obtain an approximately equal annual income, and in order to do so is obliged to fell annually, to create young woods regularly to replace those which are harvested, and also to make sure that the fellings do not exceed the increment of the woods. In this way systematic management is compulsory for him. The English owner, whose woods are of comparatively small extent is under no necessity to have annual fellings. He is content with intermittent returns, and cuts his timber simply in accordance with its maturity and the state of the market, and he sees no necessity for systematic management. Further, systematic management is very difficult under the present circumstances of English woods. In most English estates a large proportion of the woodland consists of even-aged mature or nearly mature oak, and at present prices this class of timber has a very poor sale. Felling these woods produces a very poor return and destroys the beauty of the landscape. The result is that in many cases nothing is done and the woods slowly decay. The owner hopes that perhaps some day they may be available as a reserve to meet death duties or some other pressing financial necessity.

In spite of these difficulties there are some considerations which suggest that an owner would find it to his advantage to introduce gradually a more systematic management by reducing the area of mature timber, and then by regulating both planting and future fellings so that the woods on the property may in fairly equal proportions be divided into young, middle-aged, and mature.

Every one would admit that the management of woodlands does not differ in essentials from the management of farm lands. The aim of both farmer and planter should be to preserve the fertility of the soil and to obtain the highest possible financial return by allowing none of the land to remain idle. In both cases, so long as the area remains unchanged, a fresh crop can only be raised on land from which a previous crop has been cleared. It follows that the most useful tool in woods is the feller's axe, and it is the necessary forerunner of the planter's spade. If on an estate the feller's axe is not often heard it may be assumed with great probability that planting is being neglected. It is possible that the axe is not used because the estate has been previously cleared of all mature timber, or that there are only young woods with no tree fit to fell, but these are exceptional cases. In most cases where felling is not done regularly, there are some woods which are over-ripe and should be, under proper management, felled and the ground replanted.

Systematic forestry means that an owner

should neither cut hap-hazard nor should omit to cut ripe timber merely because he is not in immediate want of money. Also that he should always replant his woods as the fellings clear the ground.

For example, if there is a woodland area consisting mainly of a wood of 100 acres of oak about 150 years old in a district where there is a good local sale for small quantities, some proportion of the area should be cut regularly, say two acres in every five years, and the felling area increased whenever there was a temporary rise in the price. The planting should be done annually, or every third or fourth year, and the intervals of time used in tending the young trees and preparing transplants for the next planting. Probably under such a plan as this, about twenty acres would be cleared and replanted in twenty years. The work would proceed as a matter of routine, with a minimum of cost and dislocation of labour on the rest of the property. Probably in the second twenty years it would be advisable to double the rate of clearing, so that at the end of forty years sixty acres would have been cleared, and all, except the few acres recently cleared, replanted.

The establishment of a nursery in or near the proposed wood greatly diminishes the cost of replanting. There is a gain in economy and efficiency when felling, planting, cleaning, and thinning are all done regularly and as matters of routine and not as occasional efforts. The greatest efficiency and economy result if an approximately equal area is planted in every year; but it is rarely possible to maintain this ideal for any lengthened period. Except on estates of considerable size there cannot be found in every year an area that requires planting. It is necessary to increase the size of the area to be planted if the area felled has been very large in proportion to the total woodland. For example, if all the woodlands had been cut during the war for pit-props and it has been decided to replant with larch on a seventy-year rotation, planting one-seventieth of the area in each year would be a mistaken policy. The economy and efficiency of continuous annual planting would be more than balanced by the loss of having the greater part of the land for many years without any crop of trees except such as might spring up under natural regeneration. In such a case the area to be annually planted might be advantageously fixed at a large figure, such as one-tenth, one-fifteenth, or one-twentieth of the whole area.

Fellings are of necessity generally intermittent. The age of the trees and the state of the markets sometimes make sales of timber impossible. Or there may not be always a sufficient quantity of mature timber to make a sale sufficiently large to attract timber merchants. Still, it is generally possible to arrange for the gradual removal of mature timber and the subsequent replanting of the cleared ground.

There is no necessity for a rigid rule; woods grow at different rates; and if the date of felling is fixed by a rigid rule timber would sometimes be cut before it was ripe and at other times left standing after it had reached maturity. Whatever plan is first adopted can always be altered, either to meet variations in the market-price of timber or to carry out improvements suggested by experience. The important thing is to have a plan, and not to cut and plant casually. In the absence of a plan there is a possibility that the woods will be cut severely when the owner is short of money, and where this is not the case the maturity of the older woods is overlooked and they are retained long after they have ceased to grow. In either case replanting is made more difficult and expensive than if it were done regularly. When woods are worked according to a plan, all the trees will be removed in course of time, and yet the woods will remain like a fleet which constantly remains at sea, though the ships go in regular order to port to refit.

The accounts of the woodland area are on many estates kept with extreme care. The general expenses and receipts are analysed and separately allocated to the different woods. This elaboration of the accounts involves an expense which seems to be out of proportion to any benefit gained. If the object of the accounts is to show the history of a wood from start to finish they must be kept with meticulous care. Even a single rail that has been cut down to mend a fence must be entered under the head of thinnings, and if it is not measured, at least its size should be indicated. In the case of owners who use accounts in order to know the financial position of their property this extreme carefulness would be mere pedantry.

In the accounts it is useful to have a separate subdivision showing the final result of the woods for the separate years. Perhaps in one year there has been a heavy felling and a large excess of receipts over expenses, and then for many years nothing has been received and expenses annually incurred. By placing on the same page the results of different years the owner can see at once the net result of the intermittent gains and losses.

A book should be kept showing the stock of timber in each wood or subdivision of a wood. The stock-taking need not be expensive. Woods under twenty-five years are sufficiently entered as good, fair, or bad, and an estimate given of the blank spaces. The cubic contents of the older woods can be estimated, and the method of estimation stated, as, for example, so many trees per acre and so many cubic feet per average tree. The entries progressively grow more accurate, both by comparison with actual measurements when trees are felled and by greater experience in forming estimates.

A book of this description, annually made up, shows the rate of increase of timber in each wood. It shows which woods are thriving and which are making slow progress. It also gives the owner knowledge of the changes in the aggreggate of timber in his woods.

One result of close attention to the growth of the timber in woods will be the disappearance of trees of the largest size. Woods will be cut down on the first favourable opportunity, after it is obvious that the value of the annual increment is considerably less than the interest which the selling price would produce if invested. The amount of wood annually added by growth to a tree continuously diminishes after a certain period in the life of the tree, and is very slight for many years before it ceases. The greatest possible size can be attained only if the life of the tree lasts as long as there is the power of making even the smallest additional growth.

The systematic forester has other objects than the production of the picturesque and grand. In the natural woodland there is much unoccupied ground, glades, thickets of underwood, many coarse ill-formed trees, and a few trees of exceptional size. When systematic forestry takes charge of the woodland these elements of the picturesque and grand disappear, except where a few escape as the result of accident and neglect. Well-formed trees are themselves so beautiful that they give a beauty to the most uninteresting scenery, but plantations are dull and heavy, except as seen from a distance in spring and autumn, when the varying tints enable the eye to dwell on separate parts of the whole mass.

AFFORESTATION

CHAPTER VIII

AFFORESTATION

THE afforestation of large areas by the State is ardently advocated as one of the most hopeful methods of reconstruction after the war. It is urged that a considerable amount of timber might, under State management, be grown on waste lands now occupied by a few sheep or by grouse or deer. Further, it is hoped that the afforestation of these waste lands would, in conjunction with a system of small holdings, establish in exceptionally healthy surroundings a population who would work in winter in the woods and in summer on their own holdings.

Very different opinions have been expressed about the total area of waste lands suitable for planting,[1] and the possibility of creating thriving plantations at an altitude above the 1,000-foot contour line. Two opposite views about the financial result of this proposed State afforestation are put forward. The one which is generally presented by writers in newspapers, is that these plantations will bring a good interest on the expenditure. Apparently this opinion is founded on a belief that the State forests in Germany and France are financially successful. This belief will not stand close investigation. The conservation of the natural forests in Germany and France may have been advantageous to those countries, but such advantages are no proof of financial success. Even if the State forests on the Continent were financially successful, their example would be relevant in an inquiry into the probable financial result of planting in the United Kingdom, only if it were shown that the new woods planted on the Continent during the last century were now producing a fair rental for the soil and a fair interest on the capital expended.

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[1] The Coast Erosion Commission estimated the total area of afforestable land for the United Kingdom at 9,000,000 acres. The Commission of the Forestry Sub-Committee, 1918, estimates the total area of afforestable land in the United Kingdom at between 4,000,000 and 5,000,000 acres.

The other view is that the State ought not to strive after financial success in the management of State forests.

Professor Schwappach, in a paper read before the Royal Scottish Arboricultural Society, said that whether the afforestation of waste lands in Scotland will be financially successful or not will to some extent depend upon whether the question is regarded from the national point of view or from the standpoint of the owner of the woodlands for the time being. His opinion was that the State ought to be content with a profit much smaller than would be sufficient for a private owner.

In 1899 the Oberlandformeister, or director of the Prussian forest department, used the following language in laying down the principles upon which the Government manages its forests:

"The Prussian State forest administration does not accede to the principles of a continuous highest soil rent based upon compound interest calculations, but believes, in contradistinction to private forest management, that it cannot avoid the obligation in the management of the State forests of keeping in view the welfare of the whole community of citizens, and therein taking into consideration the need for continued supply of wood and other forest products as well as the other objects to which in so many other directions the forest is subservient. The administration does not consider itself entitled to pursue a one-sided financial policy, least of all to submit the Government forests to a pure money-making management strictly based on capital and interest calculations, but considers it its duty to so manage the forests as a patrimony belonging to the whole nation that the present generation may be benefited by the highest possible usufruct in satisfying its wants and deriving the protection which the forest renders, and to future generations may be secured at least as large usufruct of the same kind."

It is a fair argument, that the absence of a financial profit in a State undertaking cannot be accepted as a conclusive proof of failure, for there may be indirect benefits of great value which cannot be expressed in figures. A battle-ship may be sold for one-tenth of the original cost, but there is no loss of nine-tenths. That sum is not a loss, but the cost of the advantages which the State derived from the possession of the battle-ship. Money spent on woods which fail to grow is a loss, but the cost of diminishing the national dependence on foreigners for timber and of establishing a healthy population on lands now waste is not fairly called a loss.

Still, it is obvious that before commencing a large system of State afforestation a prudent statesman would wish to have an approximate estimate of the cost per acre.

In each year of the rotation—that is, from the year in which the first area was planted to the year in which it was felled—a certain additional area would be planted, and the capital expenditure of the State for the purchase and the planting of land would continuously increase. When the first planted area was cleared the capital expenditure would cease and a perpetual income would be received. It would be the sale money of the area cleared in each year, less the cost of replanting the area cleared in the previous year.

In the present absence of all details about the length of the rotation, the cost of the land, and of maintenance, any estimate of the capital expenditure can be only a rough approximation. Yet it is possible to give some figures which are beyond doubt.

The capital expenditure per acre on the forest at the time when it becomes self-supporting cannot be less than £30.

In a letter to *The Spectator*, published in January 1914, the Duke of Northumberland pointed out that, assuming the land to be worth annually 1*s*. per acre before it was planted and the cost of planting £3 per acre, the following would be the result: namely, 1*s*. per annum invested at 2½ per cent. amounts at the end of eighty years to £12 8*s.* 4*d.*, and a capital sum of £3 invested at 2½ per cent. for the same period amounts to £21 12*s.* 7*d.* These two sums added together give a total sum of £34 0*s.* 11*d.*

These values for the purchase of the land and the cost of planting are very moderate. There is no expenditure charged for maintenance or for rates and taxes. A consideration of them is sufficient to prove that, even assuming a great reduction in the length of the rotation and that the thinnings pay for the maintenance, rates, and taxes, it would not be possible to estimate that the forests could be established at a less cost than £30 per acre.

All predictions about the financial results of afforestation are only conjectural. It is impossible to know with any form of accuracy the prices of labour and timber after the war. Probably all prices will rise. There is no present reason to think that the rise on the debit and credit side of a forest account will be unequal in amount, though the possibility cannot be entirely excluded that timber might rise in price only slightly and the expenses increase greatly.

Another conjectural view of the result of afforestation may be presented as follows. Omit all mention of interest, assume that the cost of the land and of the planting equals £10, that the rotation is eighty years and that the annual returns after eighty years are £1 10*s*., then the final result is that £10 will at the end of eighty years produce an income of £1 10*s*. per annum.

This conjecture assumes that Scotch fir is planted on very poor land. State afforestation in the United Kingdom on a large scale means, in fact, afforestation in Scotland and the planting mainly of Scotch fir, for the following reasons, viz. the land selected as the site of State afforestation must be suitable for the growth of trees, free from commoners' rights of grazing, not more than, as a maximum, 1,500 feet above sea-level, and must be near water-carriage for the timber and also near land suitable for small holdings. The land to be planted must be in a large block and not capable of being used for profitable commercial or agricultural purposes. The effect of all these requirements is that State afforestation must be mainly confined to Scotland, for nowhere else can these requirements be satisfied. Also the forest will be mainly a Scotch fir forest, though it may include Douglas fir, spruce, and hardwoods.

Scotch fir woods, if well managed, may be profitable, but they are exposed to great dangers. They are liable to damage from snow and disease, and while young are very inflammable. Their timber is sold in competition with foreign timber that has been self-sown and carried by water to English and Scotch docks.

The combination of small holdings and government employment in connection with State afforestation will increase the cost of the woods. There are several firms of good reputation who make it their business to undertake to plant by contract woods, and to replace during an agreed number of years all dead trees. The planting of the woods could be entrusted to these firms, if the only object of State afforestation was the supply of timber. Their employment would save the cost of a numerous administration and would postpone the cost of the creation of small holdings for many years, so that if it was ultimately found necessary, as the trees reached maturity, to have a resident population to work in the woods, there would be only a moderate interval of time between the expenditure on the small holdings and the receipt of money from the sale of trees.

The sums which would have been received for income tax and death duties if the land had remained in private hands will be lost. Also in a country where every public servant has a vote, there is an inevitable tendency to considerable increases in salaries, wages, office expenses, and pensions.

One objection to State afforestation sometimes urged, is that it must be bad and expensive. This objection is based on the very unsatisfactory condition of the English Crown lands. The Recent Forestry Sub-Committee of the Reconstruction Committee take confidently a different view. They say (p. 40), "We do not believe that State afforestation means expensive and inefficient action. On the contrary, we have the long experience of all the countries in which forestry has reached a high pitch of development and the promising methods of management in certain of the Crown woods of recent years to prove the contrary."

The only countries in which forestry has had a long experience and reached a high pitch of development are France and the states of the German Empire. All the countries to which the Sub-Committee refer are only two in number. Efficient is not a precise term, and opinions differ about the efficiency of the French and German Forest Administrations. Expensive is more precise, and there should be no difficulty in proving that the French and German Forest Administrations are not expensive, if such is the case. This proof has not yet been given. There is no book published in the English language containing accounts from which it is possible to ascertain the expenses of the French and German Forest Administrations. The Forestry Sub-Committee give no reference to any published accounts.

The fact that returns from forestry are long deferred may be a reason for thinking that private enterprise would be unwilling to carry out afforestation on a large scale, from which, if it is assumed that afforestation on a large scale is necessary, it follows that the work must be done by the State. Some people go much farther, and urge that, even if private enterprise is willing to carry out afforestation, State afforestation should be started, because in their opinion the State can do the work better than individuals. Their argument is that continuity of administration is essential in forestry, and that a State department gives continuity of administration with more certainty than can be expected from a succession of individuals. No historical facts are ever given in proof of the continuity of State administration. Although the states of England, France, and Germany have owned forests during several generations, no one attempts to show that these states have observed continuity of administration. It is beyond question, that it would be impossible to state any form of administration which has been continuously adopted by the states of England, France, and Germany.

These advocates of State afforestation imply that the continuity of State administration is a truism, which only requires to be stated to commend itself to every person of common sense, and that historical proofs are unnecessary. Even if this very strong assumption is granted for the sake of argument, it cannot be admitted that continuity of administration is desirable in all cases. Alterations in administration are occasionally adopted in all businesses, and are inevitable. The policy about the extension or diminution of the forest area has varied in the past and will vary as long as market conditions and opinions on economic questions are liable to change.

The zeal shown in pressing for State afforestation is not derived entirely from a consideration of the conditions peculiar to forestry, but is, to a large extent, the result of a belief that State control and management are advantageous in all branches of industry. It is said that forestry is essentially work for the State, because the returns are long deferred; and with equal zeal it is said that the management of railways is essentially work for the State, although the returns from railways are quickly realised.

As an alternative to the plan of establishing a forest by regularly planting in each year an approximately equal area, very large areas may be planted in periods of unemployment and after heavy fellings. According to this plan, in normal years forest operations would be restricted to planting small areas and the maintenance of the previously planted areas. Arrangements for intermittent work are more difficult to make than those for regular work, but with care they should not be more expensive.

A suggestion has been made that areas of about 500 acres each should be planted in different parts of England by the officials of the Board of Agriculture and Fisheries, as patterns to English owners and land agents and ideals of forest management.

The advantages of this scheme are not easily seen. It could not materially relieve the dependency on foreign supplies of timber, reduce unemployment, or establish a rural population; and seems to be based upon the assumption that the officials of the Board of Agriculture and Fisheries are better qualified than English owners and land agents to plant and manage woods.

Some recent attempts to form plantations on Crown land are sufficient proofs that it is not under all circumstances an easy thing to make woods grow, and even if under this scheme very fine woods were produced, they could give no useful lesson. It is one thing to manage woods so as to produce fine timber and quite a different thing to combine with fine timber a fair return on the expenditure.

An official who can rely on the unlimited resources of the State, and whose salary is independent of markets or seasons, must have a very sympathetic mind if he can really understand and relieve the difficulties of those who manage their own woodlands in face of increasing taxation and a precarious bank balance.

It is possible to produce fine woods by a management which is regardless of cost, so that the woods would be perfect models of the way in which English woods should not be managed if the realisation of a profit is essential.

MEASUREMENT

CHAPTER IX

MEASUREMENT

In England trees are measured by the quarter-girth. At a point midway between the top and bottom of the tree or portion of the tree to be measured, the circumference, excluding bark, is measured in inches and divided by four; the result is the quarter-girth. It is the side of a square inscribed within a circle whose circumference is equal to the circumference of the tree.

The quarter-girth when squared, divided by 144 and multiplied by the length of the tree in feet, gives the cubic contents in feet. A tree whose length is 40 feet, and whose circumference at 20 feet from the ground is 24 inches, has a quarter-girth of $24 \div 4 = 6$. The contents are $\frac{6 \times 6 \times 40}{144} = 10$ cubic feet.

This measurement gives something like 22 per cent. less than the real contents of the tree. Four portions of the area of a circle are outside a square inscribed within the circle. These amount to about 22 per cent. of the area of the circle. They are omitted by the quarter-girth measurement on the ground that the outside portions of a tree are of little or no value to a timber merchant. On the continent of Europe both the valuable and the valueless portions of a tree are equally included in the measurement. Also railway companies in England measure the whole contents of a tree if sent in the round; they use as a divisor 113 instead of 144. The measurement is taken by string under bark (or by string over bark with a reasonable allowance for the bark) except when such timber is consigned at tape over bark rates, or it is agreed that tape over bark rates shall apply.

The measurement of the quarter-girth is made either by stretching a piece of whipcord round the tree and then folding it four times and taking the result with a foot-rule, or a quartering tape measure is used.

The cubic contents are found by using a timber ready-reckoner, such as Hoppus, whereby the cubic contents of any piece of timber may be found at sight from 2 to 54 inches the side of the square (or one fourth of the girth), and from one quarter of a foot to 45 feet the length.

In measuring standing timber, the height, girth, and the allowance for bark and taper can only be estimated, and are therefore liable to dispute; but it is possible to fix the number of the trees with certainty. Counting them separately is the only method of accurately ascertaining the number of trees in a wood. Each tree should be marked by a scribe, paint, chalk, or a piece of paper. The counting should not be allowed to go to high figures; as soon as ten or twenty is reached a line should be made in a notebook and counting should commence again from one.

In order to avoid the loss of time which is necessary for counting the trees in large fir plantations the number is sometimes fixed by an estimate either derived from the valuer's experience or founded on measurements of the distance apart of the trees,[1] or the number of trees counted in small plots. The trees in a square of 7 yards, if multiplied by 100, are approximately equal to the number of trees in an acre. If the valuer measures by his own paces or otherwise several squares of 7 yards and counts the trees, the average result, multiplied by 100 and then by the number of acres in the wood, should theoretically give the number of trees in the wood. This method of estimating the number of trees is founded on the fact that there are 4,840 yards in an acre, which is taken to be equal for practical purposes to 4,900, *i.e.* 7 × 7 × 100. Also one or more fairly large sample plots, of which the size is accurately known, may be selected and the trees in them counted and the result multiplied by the fraction which the selected portion bears to the area of the whole wood as shown by the ordnance map.

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[1] See table, p. 153.

One source of error in an estimate is that a wood is usually not uniform in growth. A small difference in the distance at which the trees stand apart means a great difference in their number; the portions selected may not be really representative. Another source of error is that it not easy to know what deductions for blanks should be made from the acreage within the wood fences. Roads, paths, and bare spots when added together may be an appreciable portion of the whole area.

An error in an estimate is easily made, and disputes are very probable unless the trees are counted or great care is taken in forming an estimate. It is possible that a landowner may advertise a wood as containing about 20,000 trees, and a timber merchant, after buying it for a lump sum and felling it, may find the number to be seriously less than 20,000. Then the seller urges that the indefinite word "about" showed that the number given was only an estimate, and the buyer contends that the word covers only small differences. If the wood really contained a larger number of trees, the owner has in fact, by his erroneous estimate, made the timber merchant a present of the trees in excess of the estimate.

After the number of trees in a fir plantation has been fixed by a count or by an estimate, the cubic contents can be ascertained. The simplest method, if measuring has been omitted as too tedious, is to treat separately the trees of exceptional size and the trees which are obviously below the average size. The first class should be counted and measured. The number and cubic contents of the second class can be estimated. When these two classes have been eliminated, it should be comparatively easy to estimate the cubic contents of the average tree in the intermediate class.

The height of a tree, for the purpose of measurement, is the distance from the ground to the top of the measurable timber. In trees grown clean in woods it is the place where the crown commences. It can be guessed with fair accuracy by placing a measured rod against the lower part of the bole. After this has been done with care in a certain number of trees the eye becomes accustomed to the average height of the trees in the wood.

The girth of a tree can be found by girthing it at 5 feet from the ground and forming an estimate of the allowance to be made for bark and for the taper of the tree from 5 feet above the ground to the spot that is half of the height. In a larch wood where the trees are of less than fifty years' growth one inch off the quarter-girth at 5 feet is generally sufficient, that is, ½ inch for bark and ½ inch for taper. Also a fairly accurate estimate of the taper can be made if the tape has a hook at one end and with the help of a long stick is swung round the tree 10 or 12 feet above the ground. The rate of diminution of circumference from the ground to 10 or 12 feet of height is a fair guide to the diminution from the ground to a point half way up the tree.

All estimations of height and quarter-girth of standing timber should, if possible, be checked by careful measurements of sample trees after they have been felled.

The quarter-girth over bark of felled timber can be accurately measured. If the timber has been sold at so much a foot felled, it is a useful plan for both parties to agree to measure over bark and to find the volume under bark by a fixed deduction from the total of the measurements over bark.

In a normal larch wood, where there are no old trees, a reduction of 12½ per cent. from the total of the cubic feet over bark will represent the amount of cubic feet under bark. Should either party doubt the fairness of a reduction of 12½ per cent. a certain number of average stems can be measured over bark and then again after a ring of bark has been removed, and the difference between the cubic contents of the two measurements taken as the allowance to be made.

In normal oak trees grown in a wood an allowance for bark of 1 inch, or in some cases 1½ inches, in every 12 inches of quarter-girth is sufficient. The taper of oak trees can only be estimated after inspection of the tree, for individual differences of oak trees are much greater than in the case of larch grown closely in a wood.

Some measurers make an allowance, in standing oak timber, for bark and taper combined of 2½ inches in every 12 inches of quarter-girth. If the tree is again measured after it has been felled and barked, it will frequently be found that this allowance is somewhat in excess of an accurate measurement.

The height of a tree which it is desired to know with greater accuracy than is possible by estimation can be measured, if the tree is in such a position that an observer can stand level with it and measure the ground between himself and the foot of the tree. (1) With a pocket clinometer an observer can find the place where the top of the tree makes an angle of 45 degrees with his eye, then the distance from himself to the foot of the tree, plus the distance of his eye from the ground, equals the height of the tree[1]; or (2) by the relation of similar triangles.

Take two poles of different lengths, push the smaller one into the ground until the top is at a convenient height for the eye, say 5 feet, and put the longer pole 3 feet in front of it and between it and the tree. Take two imaginary lines from the top of the smaller pole, one to the top of the tree and one to the point on a level with the top of the smaller pole. Note where these imaginary lines cross the longer pole and measure the distance between them.

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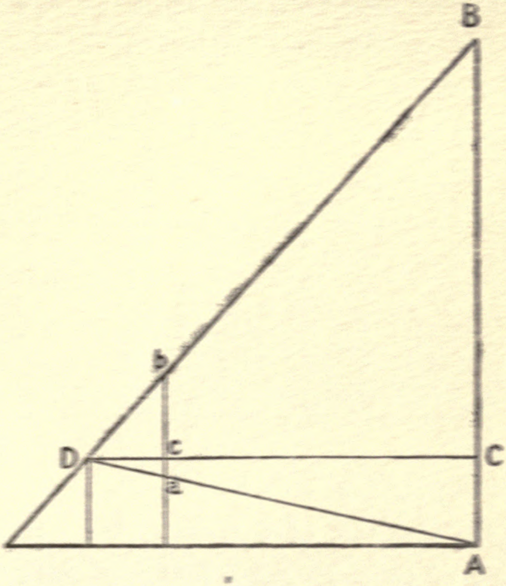
[1] In the triangle $\overset{B}{\underset{C\quad A}{\triangle}}$

If the angle at $C = 26° 34$ then $A\,B = \frac{1}{2}\ C\,A$ nearly
„ „ $= 35°$ „ $A\,B = \frac{7}{10}\ C\,A$ „
„ „ $= 38° 40$ „ $A\,B = \frac{4}{5}\ C\,A$ „
„ „ $= 45°$ „ $A\,B = C\,A$ exactly.

BA is the height of the tree, *D* the top of the smaller pole 5 feet from the ground, *b* the longer pole 3 feet in front of *D*, then $BC : bc :: DC : Dc$. Assume that *DC*, the distance of the observer's eye from the tree, is 30 feet and *bc* is 3 feet, then $BC = \frac{3 \times 30}{3} = 30$, and *CA* is equal to the height of *D*; therefore $BA = 30 + 5 = 35$; or *BA* may be found by taking an imaginary line from *D* to the base of the tree, then



see "[illegible]" in part 7 book

$BA : DC :: ba : Dc$; assume that $ba = 3\frac{1}{2}$ feet, then $BA = \dfrac{30 \times 3\frac{1}{2}}{3} = 35$ feet.

The following table of quarter-girths and lengths facilitates the calculation of contents.

6	inches	quarter-girth	is	¼	of length
7	,,	,,	,,	⅓	,,
8½	,,	,,	,,	½	,,
10	,,	,,	,,	⅔	,,
12	,,	,,	,,	1	,,
13	,,	,,	,,	1¼	,,
14¾	,,	,,	,,	1½	,,
16	,,	,,	,,	1¾	,,
17	,,	,,	,,	2	,,
19	,,	,,	,,	2½	,,
21	,,	,,	,,	3	,,

For example, if a tree has a length of 40 feet and a quarter-girth of 6 inches, the cubic contents are ¼ of 40 = 10 cubic feet. If the quarter-girth is 8½ inches, the cubic contents are 20 cubic feet, and with a quarter-girth of 17 inches the cubic contents are 80 feet—double the length.

Measurement of the cubic contents of the first 12 feet from the ground is a great assistance in ascertaining the cubic contents of a large tree. Mark with a piece of paper or something prominent the top of the first 12 feet and estimate with the eye what proportion this part bears to the whole tree.

The contents of the first 12 feet are found by squaring the quarter-girth and dividing the result by 12, *e.g.* at 6 feet from the ground the circumference under bark is 36 inches, then the quarter-girth is 9 inches, and 9 squared and divided by 12 = 6·9, the cubic contents in feet of the first 12 feet of the tree, for the cubic contents equal the quarter-girth squared divided by 144 and multiplied by the length in feet, *i.e.*

$$\frac{9 \times 9 \times 12}{12 \times 12} = 6{\cdot}9.$$

PLANTING TABLE

Number of trees in an acre, defined by the Weights and Measures Act, 1878, as containing 4,840 square yards.

Distance apart in feet.	Number of Trees.	Distance apart in feet.	Number of Trees.
1	43,560	9½	482
2	10,890	10	435
3	4,840	10½	395
3½	3,546	11	360
4	2,722	11½	339
4½	2,151	12	302
5	1,742	13	259
5½	1,440	14	222
6	1,210	15	193
6½	1,031	16	170
7	889	17	150
7½	774	18	134
8	680	19	120
8½	603	20	109
9	537	22	90

The formula is

$$\frac{43{,}560}{\text{distance apart} \times \text{distance apart}} = \text{number of trees.}$$

PUBLIC BURDENS

CHAPTER X

PUBLIC BURDENS

THE rating of woodlands, not subject to any right of common, is regulated by the Rating Act of 1874. Prior to 1874 land used merely as woodland was not rateable. The earlier rating statute of Elizabeth expressly mentioned saleable underwoods; it was therefore considered that growing timber was excluded; Secondly, independently of the statute, there was a difficulty in the nature of things in rating growing timber, because the rate is made for short periods, and to rate a man in respect of timber which might not be fit to cut until his grandson's time, might fairly be thought inequitable. Saleable underwoods were in a different position, because they were cut from time to time and produced a profit at short intervals.

Such being the law, the legislature came to the conclusion that land used for growing timber ought not to be entirely exempt.

The Rating Act 1874 (37 & 38 Vic. c. 54), provides, § 4: The gross and rateable value of any land used for a plantation or a wood or for the growth of saleable underwood shall be estimated as follows:

(*a*) If the land is used only for a plantation or wood, the value shall be estimated as if the land, instead of being a plantation or wood, were let and occupied in its natural and unimproved state.

(*b*) If the land is used for the growth of saleable underwood, the value shall be estimated as if the land were let for that purpose.

(*c*) If the land is used both for a plantation or a wood and for the growth of saleable underwood, the value shall be estimated either as if the land were used only for a plantation or wood, or as if the land were used only for the growth of saleable underwood growing thereon, as the Assessment Committee may determine.

There appears to be no definition of "unimproved state." Probably it means without the addition of any value which the trees and the planting may have given it, and the whole expression, "natural and unimproved," is an attempt to define what is popularly called "prairie value." No increase above the prairie value can be made in the assessment in respect of any benefit which user for agricultural purposes might give (*Corp. of Liverpool* v. *Chorley Union*, 36 L.T. 108; 41 J.P. 231), nor, when farm land is planted, because the prairie value is less than the value which it had when used for agricultural purposes.

It is very difficult to give a cash value to the annual rental of land assumed to be in a natural and unimproved state. The main ingredient of value in most land is its capacity to produce valuable returns as the result of the expenditure of money and labour on it. Some lands have been under wood from time immemorial, and therefore their natural state may be considered as woodland, and until they are improved by the removal of the roots their annual value is nil for any other purpose than growing timber. Agricultural land that has been planted would, in very few cases, have had any value for agriculture if the farmer had been compelled to use it in a natural and unimproved state.

If the land in its natural and unimproved state would have an enhanced value from the presence of game, such enhanced value may be taken into account in the assessment of it (*Eyton* v. *Overseers of Mold*, 1880, 6 Q.B.D. 13).

Five shillings in the £ is a very usual figure at which Assessment Committees assess the rateable value of woodlands including the sporting rights. Five shillings is almost always in excess of the annual value of the land in its natural and unimproved state. In very many cases it is in excess of the annual rental that can be obtained for the land and the trees on it.

Land used for a plantation or a wood or for the growth of saleable underwood, and not subject to any right of common, is entitled to the three-fourths exemptions conferred on woodlands for the general district rate made by an urban district council and the rate for special purposes made by a rural district council, under §§ 211 and 212 of the Public Health Act, 1895. Woodlands derive no benefit from the Agricultural Act, 1896, 59 & 60 Vic. c. 16, and are not entitled to the one-half exemption given to "agricultural land."

INCOME TAX

The owner of woodlands is assessed for the purpose of Income Tax under Schedule A in respect of the annual value; that is, the imaginary rent which could be obtained for it. The amount is fixed by Commissioners acting under the Income Tax Acts. Apart from exceptional cases this amount is in practice the same as the assessment under the Poor Law Rating. The Commissioners adopt the Poor Law figure, unless there is reason to the contrary.

The owner of woodlands is liable to payment of Income Tax under Schedule B in respect of the profits arising from the occupation of the land. The assessment for Schedule B is an amount equal to the rent or full annual value. Thus the assessment under Schedule B, like the assessment under Schedule A, in practice is the same figure as the assessment of the prairie value fixed under the Poor Law. It is apparent that during the growth of the trees the annual value derived from the land is either nil or a nominal figure. The assessment under Schedule B is a hypothetical value, which is either non-existent or greatly in excess of the income which the owner receives.

Two recent statutes give an occupier of woodlands an option to be charged to Income Tax under Schedule D (which deals with the profits arising from trades and professions) instead of under Schedule B. The assessment under Schedule D is the average profit of the three years preceding the year of assessment.

The Finance (No. 2) Act, 1915, § 22, sub-sec. 4, provides as follows:

(4) Any person occupying woodlands, who proves to the satisfaction of the General Commissioners that those woodlands are managed by him on a commercial basis and with a view to the realisation of profits, may elect to be charged to Income Tax in respect of those woodlands under Schedule D instead of under Schedule B, in the same manner as a person occupying lands for the purpose of husbandry only, and § 18 of the Customs and Inland Revenue Act, 1887, shall apply accordingly, subject as follows:

(*a*) Any such election shall extend to all woodlands so managed on the same estate; and

(*b*) The election shall have effect, not only as respects the year of assessment men-

> tioned in that section (A.D. 1915), but also as respects all future years of assessment so long as the woodlands are occupied by the person making the election.

The last Act (6 & 7 Geo. V. c. 24), § 38, provides:

(1) Any person occupying woodlands who proves to the satisfaction of the Special Commissioners that those woodlands are managed by him on a commercial basis, and with a view to the realisation of profits, shall have the same right under sub-section (4) of § 22 of the Finance (No. 2) Act, 1915, to elect to be charged under Schedule D as a person who proves those facts to the satisfaction of the General Commissioners, but an application to prove those facts in any year in respect of the same woodlands must be made either to the General or Special Commissioners, and not to both.

(2) Paragraph (*a*) of sub-section (4) of § 22 of the Finance (No. 2) Act, 1915 (which provides that the election shall extend to all woodlands managed on the same estate), shall not apply to woodlands which are planted or replanted after the passing of this Act, if the person occupying those woodlands gives

notice to the General or Special Commissioners within a year after the time when they are so planted or replanted that they are to be treated for the purpose of that paragraph as being woodlands on a separate estate.

(3) Section twenty-three of the Customs and Inland Revenue Act, 1890, 53 & 54 Vic. c. 8 (which gives relief to trading persons in case of loss), shall, where a person occupying woodlands has elected to be charged to Income Tax in respect of those woodlands under Schedule D, apply to losses on those woodlands as it applies to losses in any trade.

Under both the Acts of 1915 and 1916 the right to claim assessment under Schedule D is limited to the case of woods managed on a commercial basis, and the election is irrevocable so long as the woodlands are occupied by the person making the election. Under the earlier Act the election extends to all the woodlands on the same estate. Under the later Act an owner can claim to have the woods planted or replanted since July 19th, 1916, treated for the purpose of Income Tax as being woodlands on a separate estate.

A doubt was expressed by some owners, lest by electing to be assessed under Schedule D they might have to bring into account the receipts from the sale of timber during the two years immediately preceding the year when replanting was begun and in which they first came under Schedule D.

A correspondence between the Central Land Association and the Inland Revenue on this point has been published in the *Journal of Forestry*, April 1917, Vol. xi., No. 2, at p. 135. It appears that in the opinion of the Board of Inland Revenue, when an occupier of woodlands elects for assessment to Income Tax Schedule D —as for a separate estate—under the provisions of § 38 (2) of the Finance Act, 1916, the computation of the profit or loss falls to be made as in the case of a business newly set up, no regard being had to the profits or losses arising from the land in question prior to the date of the replanting. It is difficult, if not impossible, to assess fairly for the purposes of annual taxation property which has no annual income, but produces a fund composed partly of income and partly of capital at widely separated periods, and when in the interval between these periods there are annual outgoings.

The Finance Act, 1916, recognises the fact that timber-growing necessarily involves no returns and constant losses for many years, and extends to losses on woodlands the relief given by § 23 of the Customs and Inland Revenue Act, 1890, 53 & 54 Vic. c. 8, in the case of loss in business.

In the House of Commons a request was made for an explanation of this clause. The Chancellor of the Exchequer said that he would illustrate the effect of the clause by a concrete example. "A man whom he would call 'X' had lands which he proposed to plant or replant with timber. Within a year of the planting 'X' satisfied either the General Commissioners or the Special Commissioners that he was managing a newly planted woodland on a commercial basis. He elected for Schedule D assessment, and intimated that these woodlands were to be treated as a separate area, a distinct unit, for Income Tax purposes. That was to say, that these woods, managed on a commercial basis, were to be cut out for Income Tax purposes from the rest of the estate, and were to be dealt with under Schedule D. On the conclusion of the first year's operations 'X's' accounts would show a loss. There would be an excess of expenditure over receipts, because he did not cut his timber in the first year. For some years there would be little or nothing to show in the way of receipts. 'X' would have paid Income Tax under Schedule A on the rental value of his woodlands, and he would now come forward and invoke the aid of Sub-clause 3 of Clause 38 of the Finance Bill (the clause now in question).

"Suppose the net Schedule A assessment to be £500 and the loss shown on the year's account to be £300, the loss for Income Tax purposes would be £800, and 'X' would be repaid the whole of Schedule A tax, which was on £500, and the further tax on £300. That was to say, he was repaid where he had no profit, but loss. This process would go on until the tide turned and profits began to be realised. When profits did begin to be realised he would be assessed on Schedule D on a three years' average. In this way, for the whole period from the first planting until the final cutting 'X' would have borne Income Tax upon the actual profits from the woodlands, neither more nor less."[1]

The right to have newly planted or replanted woods assessed under Schedule D as a separate estate seems to be a real relief to growers of timber. It is probable that there will be very few cases in which it would be advisable to claim to be assessed under Schedule D for mature woodlands which during the years of growth had been assessed under Schedule A.

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[1] *Journal of Forestry*, October 1916, Vol. X., No. 4, p. 317.

DEATH DUTIES

Death Duties on timber are at present regulated by § 9 of the Finance Act, 1912 (2 & 3 Geo. V. c. 28), which provides:

Where an estate in respect of which Estate Duty is payable on the death of a person dying on or after the 30th day of April, 1909, comprises land on which timber, trees, wood, or underwood are growing, the value of such timber, trees, wood, or underwood shall not be taken into account, in estimating the principal value of the estate or the rate of Estate Duty, and Estate Duty shall not be payable thereon, but shall at the rate due to the principal value of the estate be payable on the net moneys (if any) after deducting all necessary outgoings since the death of the deceased which may from time to time be received from the sale of timber, trees, or wood, when felled or cut during the period which may elapse until the land on the death of some other person again becomes liable or would but for this sub-section have become liable to Estate Duty.

By this Act the Estate Duty is payable at the date of sale when the timber, trees, or wood are sold apart from the land, and by prior Acts it is also payable if at any time the timber, trees, or wood are sold with the land. That is, no Duty is payable until a sale.

The concession given by the Finance Act, 1912, is that the value of the timber is not aggregated with the value of the estate so as to raise the scale on which Duty is payable. The value of the estate without the timber determines the scale of Duty for both timber and estate.

No Duty is payable on the sale of underwood sold separately from the estate, but their value is not to be taken into account in estimating the principal value of the estate or the rate of Estate Duty.

There are two ways of valuing an estate, so that the value of the timber, trees, wood, or underwood is not taken into account. In the first, the estate is valued at the price for which it would then sell, if offered for sale with the timber on it, and then the timber, trees, wood, or underwood are valued at the price for which they would sell, if offered for sale, and that value is deducted from the value of the estate, and the result is the value of the estate without taking into account the value of the timber, trees, wood, or underwood. In the second way of valuing, the estate is valued as if it were stripped of the timber, trees, wood, or underwood. In most cases trees add very greatly to the value of an estate, by shelter, ornament, and facilities for sport, and their removal would depreciate the estate to an amount much greater than their sale value. In other cases the removal of the trees would add to the estate useful pasture or grazing ground.

It seems clear that a valuation of the trees should be made at the date of the succession, and therefore it may be presumed that on the occasion of sales, Duty will be payable on that valuation and not on that valuation increased by the subsequent growth. There is no definition of " necessary outgoings."

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